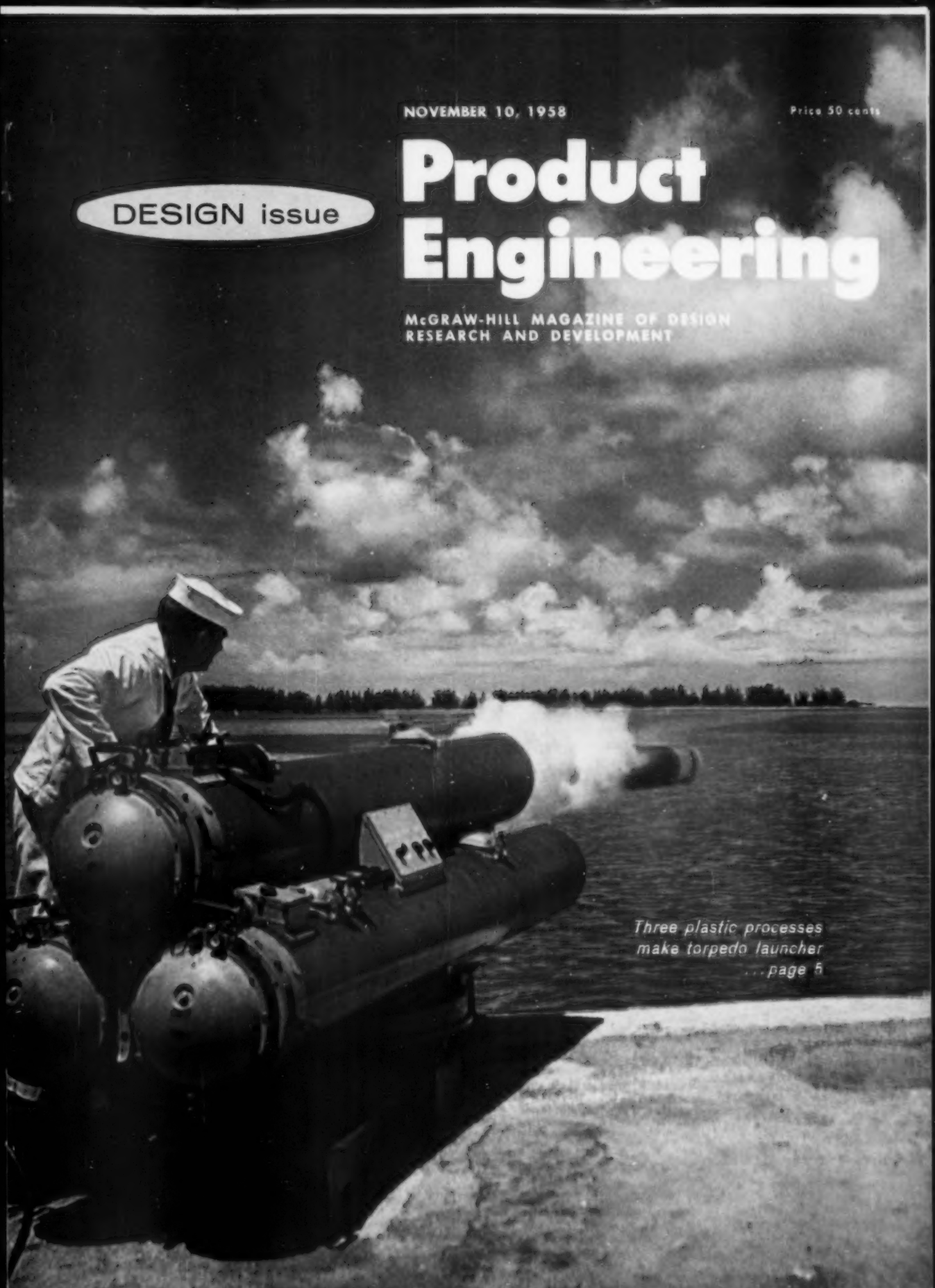
NOVEMBER 10, 1958

Price 50 cents

DESIGN issue

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT



Three plastic processes make torpedo launcher
...page 5

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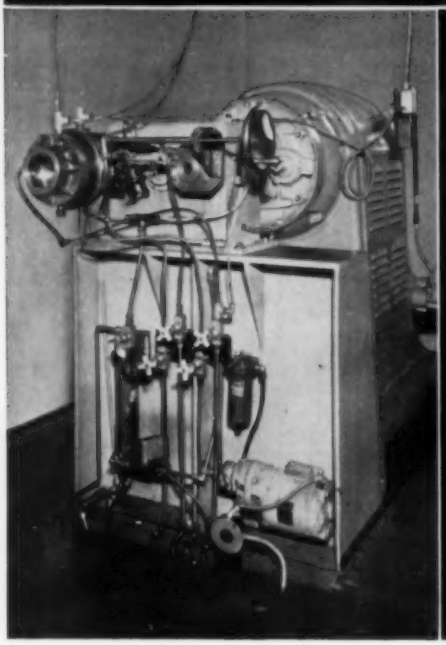

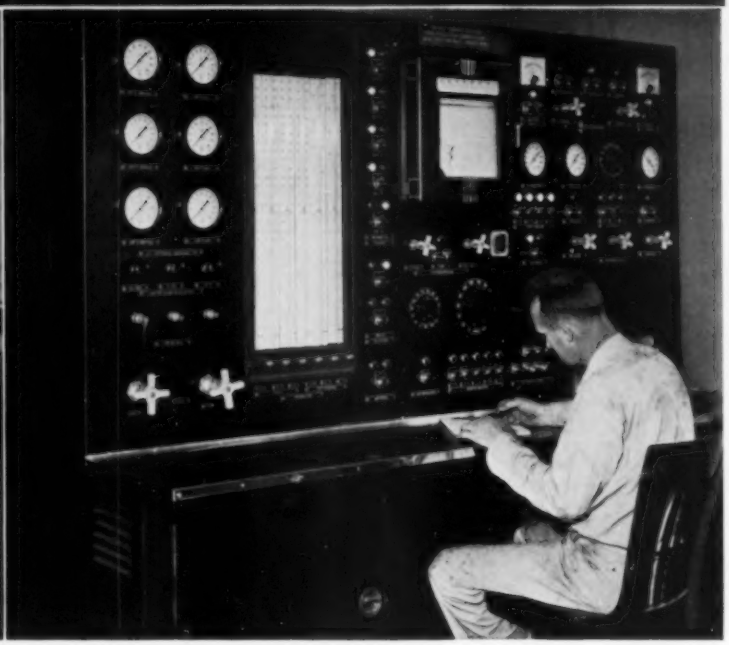

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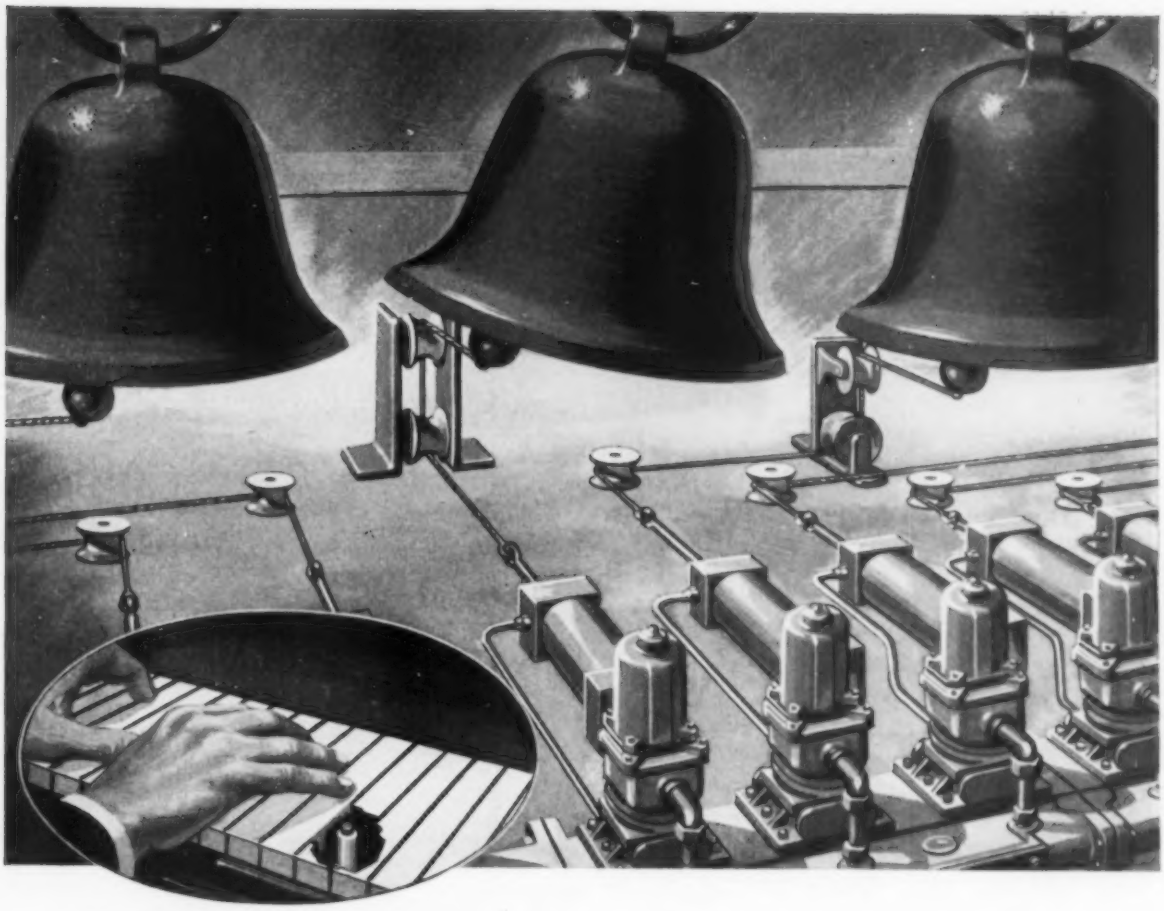


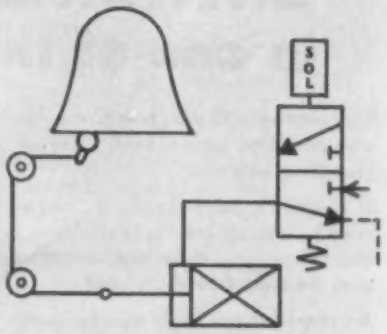
What? Air Power Rings the Bells!

Air powered clappers for the bell tower may be strictly fiction, but . . .

Can you imagine a keyboard that's a set of electrical switches. They operate a set of solenoid valves which in turn advance and retract cylinders. The cylinders, of course, pull the clapper cords. Shows that anything can happen when an air-minded engineer gets in the spirit of the season. But while this is just a flight of the imagination that you aren't likely to see installed in a carillon soon, you might very well want to take advantage of the underlying idea in some of your *plant operations*. Here is the idea:

Just one operator can control hundreds of operations by using solenoid valves.

And these solenoid valves, you'll notice, are manifolded. The manifolding saves piping, space, etc., just as has been possible for years with Ross valves that are operated manually, by air, cams, etc. Incidentally, you won't find this manifold in our catalog . . . it is one of the many refinements and variations of the standard Ross line that make it so flexible. To keep fully aware of the developments continually being made to increase the flexibility of the Ross line, keep in close touch with your local Ross Valve Engineer.



SEQUENCE OF OPERATION

Every time solenoid is energized, bell clapper is pulled against bell.

ROSS OPERATING VALVE CO. 114 East Golden Gate • Detroit 3, Michigan

Diver wields Monel "vacuum cleaner" in one of the world's most ticklish jobs

This photograph was taken in a ½-million-gallon tank at Miami's fabulous Seaquarium.

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Millions of gallons of ocean water must be circulated through the tanks each day to keep these sea denizens hale and hearty. This warm salt water itself is extremely corrosive. Besides, it contains sand and debris that are hard on metal equipment.

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In fact, they depend on Monel alloy wherever they need long, trouble-free service: in railings, ladders and handrails that must withstand salt water, spray and sea air . . . feeding baskets . . . and, of course, for the tank floor vacuum cleaner.

Do you have a metal problem? One where corrosion or some other destructive condition is causing trouble? Then send now for our booklet, *Standard Alloys for Special Problems.* It may suggest a practical answer to a ticklish problem facing you.

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

NOVEMBER 10, 1958 Vol. 29, No. 46

Springs That Store Energy Best ✳ **71** ... K W Maier, Olin Mathieson Chemical Corp.
It depends on the shape and material—explaining why a bar of reinforced plastic can beat a standard helical or cantilever. The theory is here; so are practical tables comparing candidates.

Guide to Designing for Reliability **76** ... D N Chorafas, Catholic University of America
Equipment must go on working—often under difficult conditions. Here's how reliability can be pinned down—and put to work.

Non-Clogging Centrifugal Pumps **78** ... T Ygge, A B Skogland & Olsen Co
New designs from Sweden feature impellers with twisted vanes. Article compares them with other specials for pulpy liquids.

Design Features in New Products **80** ... Plastics hurl US Navy torpedoes (our cover photo explained with design details); hydraulic motor doubles as truck wheel; mechanized straightedge for checking bumps on new highways.

New Techniques in Lubrication **84** ... Ernest Rabinowicz, Massachusetts Institute of Technology
Guest editor reviews 16 research papers presented at the recent ASLE/ASME Lubrication Conference in Los Angeles.

Best Recipe for Casting Urethane Foam **86** ... Harry Gerstin, American Latex Products Corp
The "cake-mix" method will turn polyurethane into strong, lightweight parts—if you know the latest about cavity design, resin choice, production controls. This article supplies the details.

For Measuring RPM—✳ Which Tachometer? **89** ... H D Drage, General Electric Co
Rotational speed can be clocked with a variety of devices ranging from resonant reed to stroboscope and electronic counter. Selection chart matches the method to the need.

DESIGN FILE

Packed Glands for High Pressure **94** ... J L Thomson, England (a foreign digest)
These design hints will help answer sealing problems.

How Much Stress on a Bearing Ball? **97** ... J E Ruzicka, Barry Controls Inc
Curves indicate permissible loads when seat is spherical or flat, steel or aluminum.

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Interesting to Note . . .

"Damn the Torpedoes!"

Germany's efforts at blockading her European foes from merchant shipping during the early days of World War II were almost too successful. Europe's lifeline to America was under constant strain as U-boats hovered in packs beneath the sea, lying in wait for the next convoy to pass. In 1941 and 1942 alone, enemy torpedoes sank 12.6 million tons of allied shipping. If there was still doubt in the minds of those who had been pooh-poohing the torpedo as a tactical weapon, the tales from rescued mariners soon corrected their faulty knowledge.

By mid-'43 the Germans had a torpedo, the Gnat, that was guided to its kill by the sound of a ship's propeller. About this same time a potent antisubmarine torpedo called Project F was developed by the General Electric Co. This torpedo, in the words of Hitler himself, finally slowed down the German submarine menace. Now, our cover shows the latest in torpedo warfare. A reinforced-plastic launcher is firing a deadly Mark 44 tin fish from a test stand. The launcher is being produced by the Apex Reinforced Plastic Div of White Sewing Machine Corp, Cleveland. How it's designed is shown on p 80.

During the Civil War, building a torpedo was easy as pie when the Confederate States decided to use submarines against the Union Navy; launching or detonating them was something else again. The Confederate's first torpedoes were empty beer barrels lined with pitch and filled with explosives. Contact fuses studded the exterior and the whole shebang was moored in a harbor entrance. Of all Confederate torpedoes 90% were of this type; others, at outbreak of the war, were detonated from shore by an electric current through a wire.

Matthew Maury, whose topographical hydrographic chart of the Atlantic Ocean made the Atlantic cable a possibility, had left his position as head of the Naval Observatory to design torpedoes for the Confederacy. In 1862, he mined the James River, practically isolating Richmond from a sea attack. Two years later as the Union steam corvette, named *Commander Jones*, cruised up the James hunting for gun emplacements, Maury's assistant, Lt. Davidson, saw her coming and, concealed in a marsh, waited for her to pass over one of the mines. When she did, he made a connection by touching two wires from the mine to a galvanic pile. The explosion blew the ship's engine and boilers 50 feet up in the air; out of a crew of 150 men only three lived to tell the tale. Union

(Continued on page 7)

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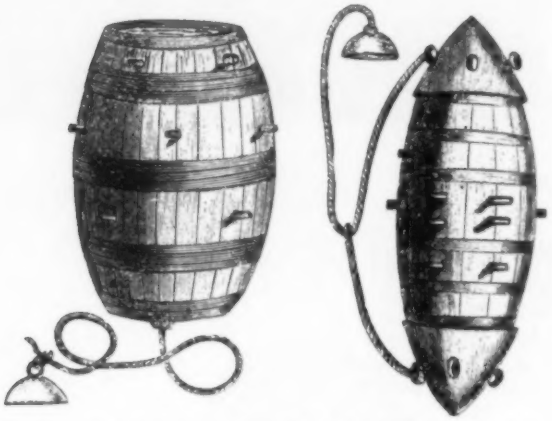
Interesting to Note . . . . *(continued)*



Confederate keg torpedo. This sketch originally appeared in *Harpers Weekly*.

forces further down the river, fearing a Confederate torpedo attack on their entire Navy, scuttled some of their own ships in the channel to barricade themselves out of Richmond and away from Confederate subs. That same year, off Fort Sumter, the Confederate sub *Hunley* torpedoed and sank the *USS Housatonic* but did it the expensive way—she sank too. The *Hunley* had already set up some sort of bad-luck record. Before meeting the *Housatonic*, she had gone out on four successive sea trials—had sunk each time and brought death to an entire crew at each sinking.

Hooke on Gravity

In many cases a scientist has received lasting acclaim despite the oversight of his greatest achievements. Joseph Henry, for example, had discovered electromagnetic induction several years before Faraday. Yet because Faraday's experiments and findings reached print first, Henry's work is overlooked. Robert Hooke was another notable who, because he failed to publicize his ideas fast enough, took a seat behind one of the world's great thinkers.

In 1674, Hooke wrote that all celestial bodies had a gravitational attraction toward their centers; and, that all bodies continued to move in a straight line except when they were pulled aside by some force. He added, that an unknown law caused gravitational attraction to diminish as distance increased. It has been said that Newton had reached the same conclusions but had neither published nor mentioned his theories. Six years after Hooke recorded his ideas he wrote a letter to Newton, asking him what form the orbits of the planets would have if it was assumed that gravitational attraction was in inverse proportion to the square of the distance. Had Hooke been able to deduce mathematically this principle he would have stolen Newton's thunder. When Newton finally published his book, *Principia*, there was not a mention of Hooke's work.

Fortunately, Hooke was greatly concerned, earlier in his life, with the efficiency of springs (p. 71) and gave the world the device found in all watches today, the hair-spring balance wheel.

A Break for the British

For one desperate week, from May 29 to June 4, 1940, 330,000 members of the British Expeditionary force in France were evacuated from Dunkirk. The Germans had the area completely surrounded and the hustle and bustle of British activity kept no secrets from enemy intelligence agents. One highlight in this dramatic week came after a large quantity of arms and ammunition was assembled and placed aboard ships for England. As each ship was loaded, enemy agents relayed the information to the German Navy waiting out in the Strait of Dover like wolves ready for a kill. To make matters worse, a new exploder mechanism had become available for the German torpedoes.

When the convoy left Dunkirk, U-boats attacked in unison; they had no difficulty finding their prey. However, when their torpedoes were fired they passed harmlessly under the ships. The reason for failure? The magnetic environment in these waters was significantly different from that of the North Sea where the mechanism had been successfully tested.

As our article on reliability points out on page 84, the addition of more components increases complexity and greatly decreases and reliability of an over-all system. Had the less-complex-type torpedoes been used, there might have been quite a different story to tell today about Dunkirk.

How Fast Can We Go?

A pilot is taught to expect anything. This was dramatically brought to light just two years ago when a Navy pilot was flying a routine test over Long Island. A few moments after he fired a burst from his .50 caliber machine guns his jet began buffeting and his engine flamed out. He had to crash-land. Only then did he discover that the jet plane had shot itself down by overtaking and colliding with its own bullets. Less than 20 years ago, it was front page news when a Thunderbolt "exceeded 470 mph" in a dive; now a plane can shoot itself down!

To further dramatize the evolution of progress, our first military plane, in 1910, had a guaranteed speed of 42 mph. Yet this in its day was a tremendous forward step. Remember that until man first broke the "oat barrier" in 1830 with the invention of the iron horse, he had been limited for 30 centuries to travel only as fast as his steed would carry him—about 30 to 35 mph.

Measuring the speed of today's planes, ships and machines (p. 89) presents problems totally foreign to our ancestors. To them speed was measured in hours or days, not miles or rpm—to travel from St. Louis to Portland, Ore. via El Paso and San Francisco in 1858 took a month. Actually this, for its day, was very good. It took the Conestoga wagons close to a year just to travel 3000 miles across country. Now it can be done under two hours.

—Benedict A. Leerburger Jr.

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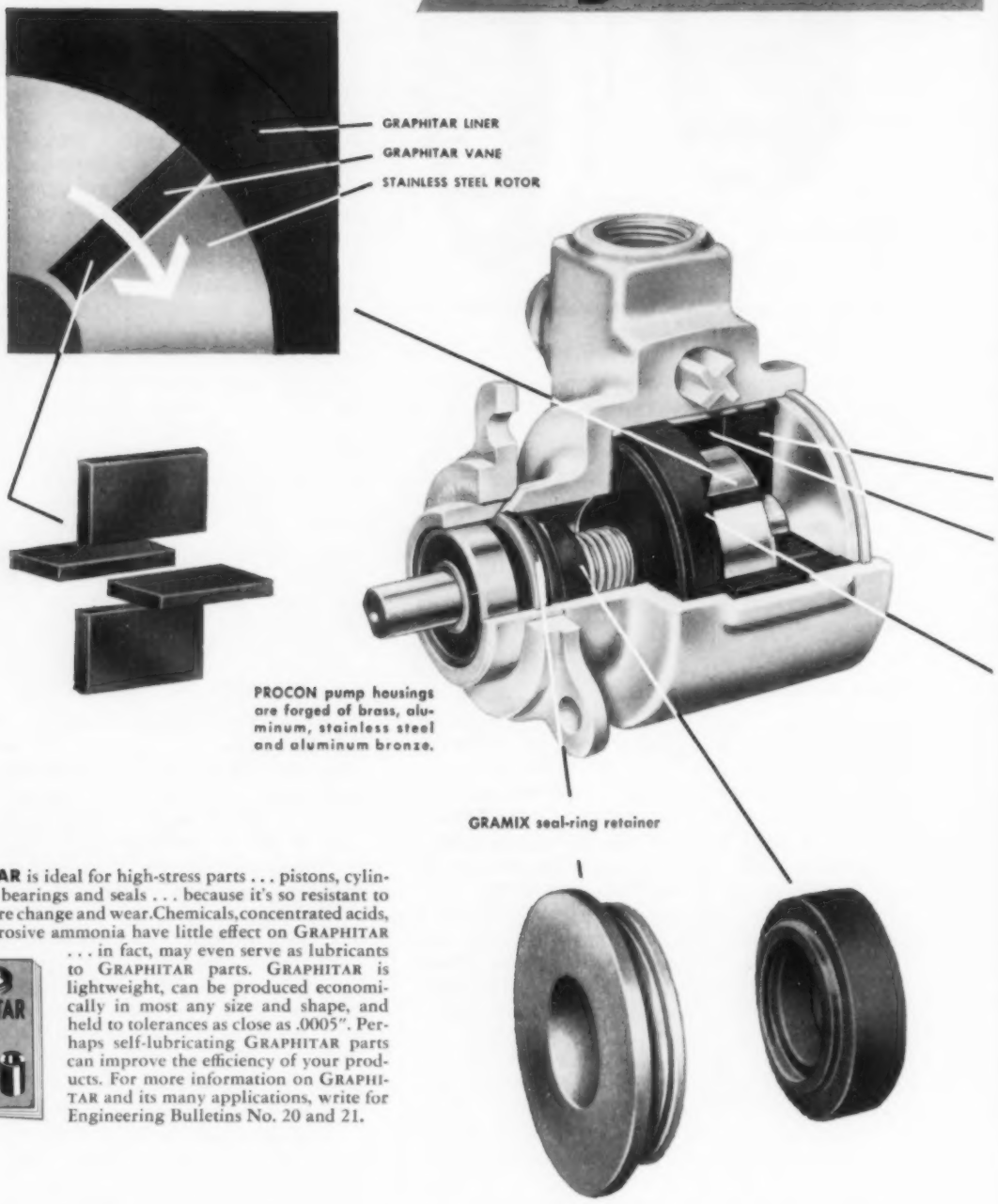
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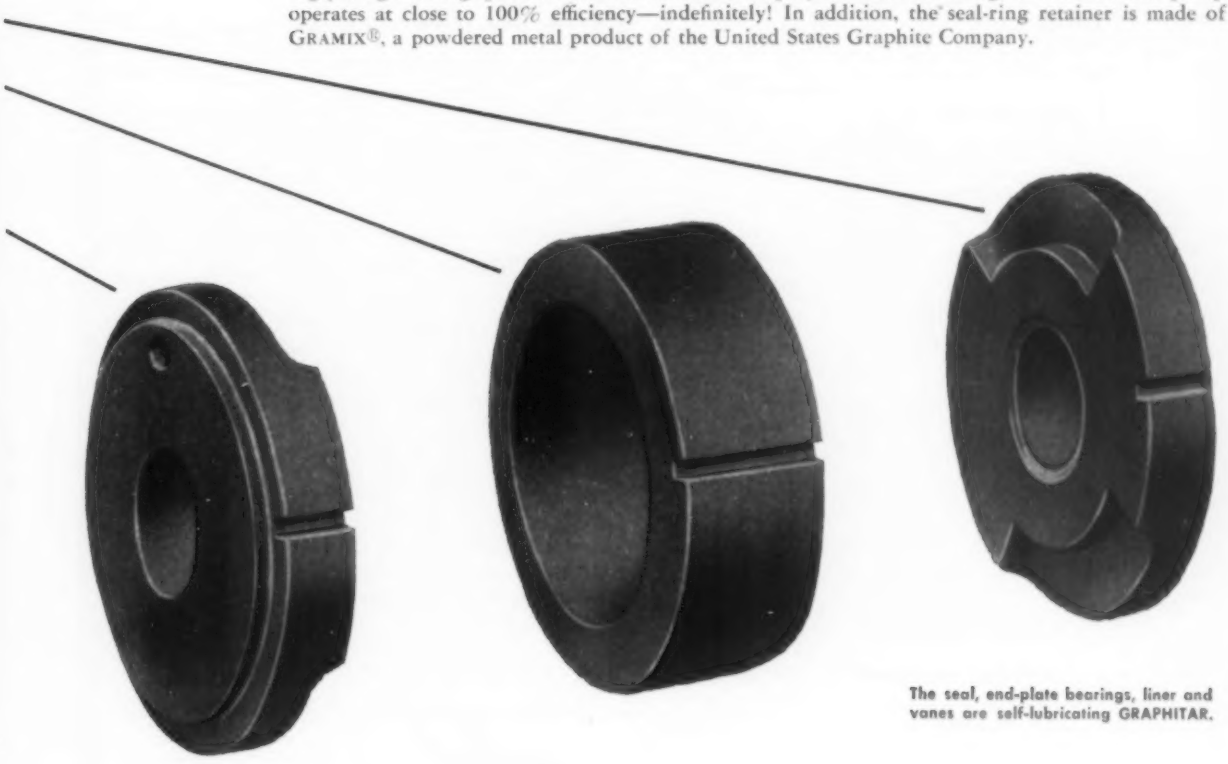

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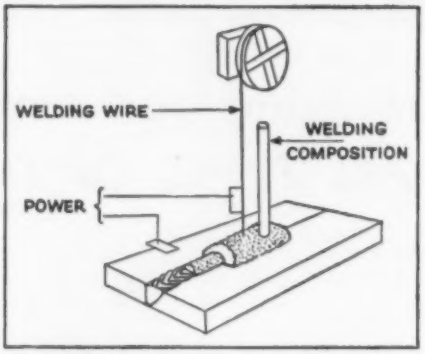
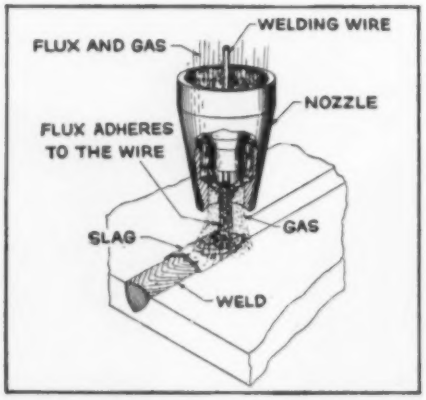
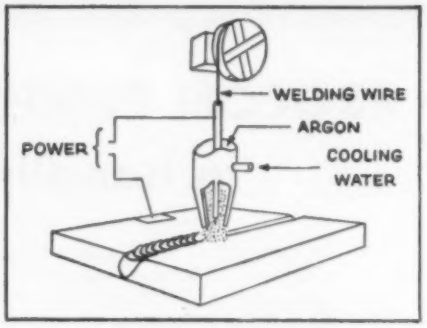


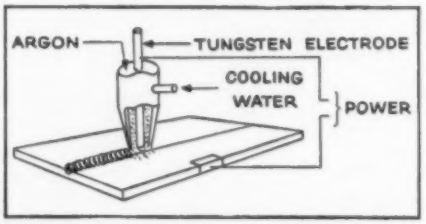
UNIONMELT Welding is a submerged arc process for high-quality electric welding at high speed of any thickness of commercially-used steel, without flash, glare, or sparks. UNIONMELT Welding equipment and supplies are available from LINDE.



UNIONARC Welding is LINDE's newest development in manual electric welding, using a magnetic flux with gas-shielded arc. UNIONARC Welding is extremely fast and economical; can be handled in all positions—vertical, overhead, downhand.



Sigma Welding—A superfast, shielded inert gas metal arc method for production electric welding of aluminum, stainless steel and other metals. LINDE supplies equipment, consumable electrodes, and inert gases for Sigma welding.



HELIARC Welding makes clean, smooth welds electrically without flux, in practically all commercial metals at high speed. HELIARC Cutting Apparatus is fast, flexible, and versatile. LINDE supplies equipment and inert shielding gas for both types of apparatus.

• • •

ARGON GAS . . . RODS . . . WIRE

LINDE Argon—guaranteed 99.995% pure—and all welding rods, wire, and other materials you need can be obtained from LINDE sources conveniently located all over the nation.

Complete information about any LINDE method or product can be obtained from your nearest LINDE office. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK

UNION CARBIDE

The terms "Linde," "Unionmelt," "Heliarc," "Unionarc" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

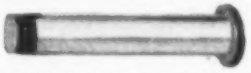
"Full-round" design of Link-Belt LXS chain avoids stress raisers

ROLLERS are accurately machined for correct operating clearances and free-rolling action.

SIDEBARS of selected steel have accurately machined "full-round" pitch holes, which maintain firm, tight press fit of pins and bushings.

FOR POWER TRANSMISSION, LXS chain is generally supplied with offset sidebars. Uniform stress distribution provides extra chain life and safe dependable operation.

FOR CONVEYING AND ELEVATING, LXS chain with straight sidebars and rollers to meet varied operating conditions. A wide variety of attachments is available.



"FULL-ROUND" PINS are made from a tough steel, specially treated for high strength in shear . . . sized for controlled press fit to prevent rotation in sidebars.

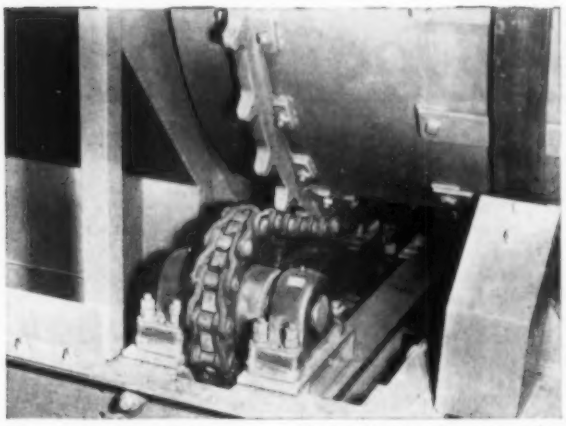
"FULL-ROUND" BUSHINGS are properly hardened to shrug off shock, resist wear . . . accurately sized for controlled press fit to prevent rotation in sidebars.

Greater live bearing area extends life

Stress concentration points are eliminated in Link-Belt LXS chain! "Full-round" design avoids sharp corners which may be the starting points of chain failure . . . provides maximum live bearing area between pin, bushing and sidebars. As a result, stress is distributed evenly . . . long chain life is assured under severe conditions.

Pins and bushings of LXS chain are accurately sized . . . assuring controlled press fits, preventing rotation in sidebars. Similar accuracy in machining of sidebars permits close control of pitch and proper chain length after assembly.

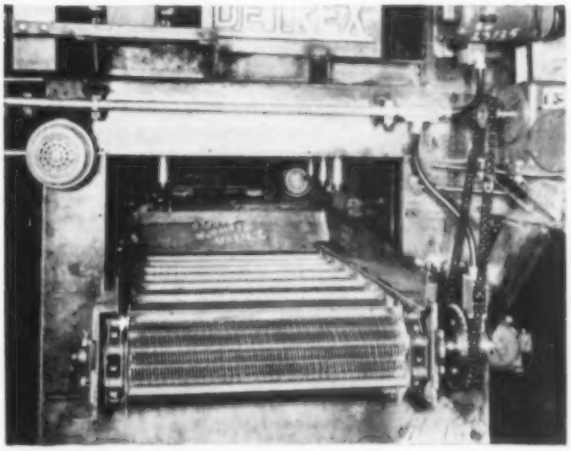
Other long-life features of Link-Belt LXS chain include use of selected steels and controlled hardening of all parts. Both contribute to greater endurance . . . greater uniformity.



LXS drives stand up to impact and abrasive service

Large, live bearing area makes LXS chain ideal for exposed drives and abrasive conditions such as found on this heavy rotating drum. Uniform distribution of load over ample bearing area reduces cutting action of abrasives . . . extends chain life.

LXS chain has stamina required for long, heavy-duty conveyors



With its exceptional strength and wear resistance, Link-Belt LXS chain can easily meet rugged conveying and elevating requirements. Due to accuracy of pitch and attachment spacing, plus close matching of multiple strands, LXS has the added strength and wear life necessary for the extra-long conveyors so important to today's highly mechanized industry.

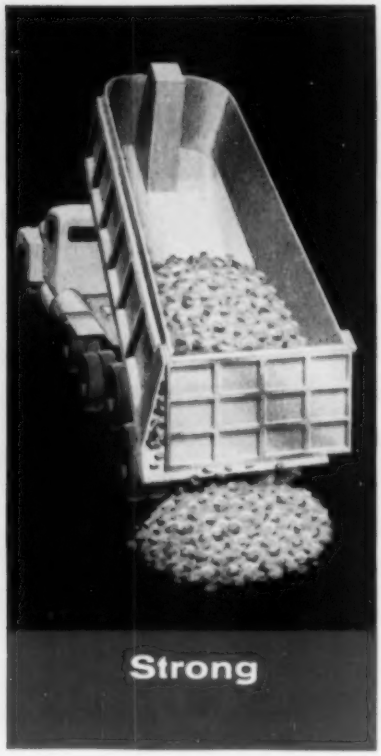
HEADQUARTERS for chains, sprockets and other Link-Belt conveying and mechanical power transmission products is your nearby Link-Belt office.

LINK-BELT

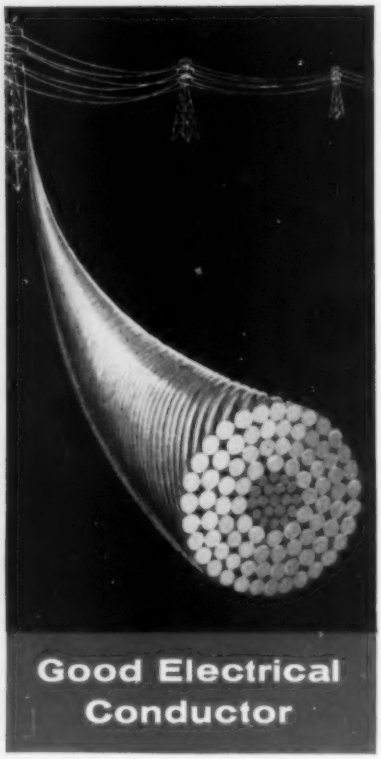
CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,741

Light Weight



Strong



Good Electrical Conductor

ALUMINUM...*Design-able*

There is probably no one metal with so many favorable characteristics, offering so much to so many applications, as aluminum. It is the *combination* of these characteristics that helps aluminum to improve products, parts, and their production.

As proof of this, consider the staggering growth in usage that this versatile metal has enjoyed just since 1946—over 2 *billion* pounds more aluminum used in 1957 than in 1946. Consider, too, a few of the properties aluminum offers a designer:

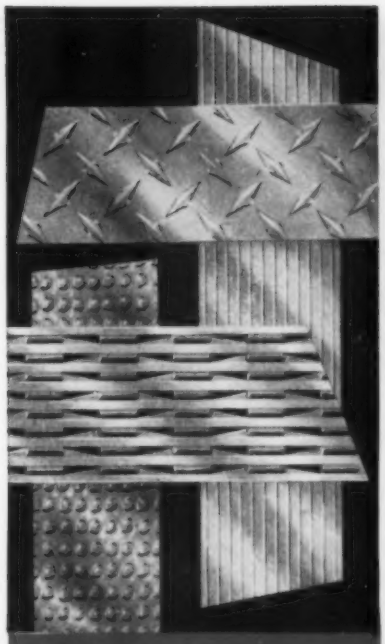
Light Weight—Weighing ⅓ as much as copper, steel and brass, aluminum offers a big advantage for many products where weight is important. Light weight can also mean lower labor costs, lower costs in shipping, handling and installation. And you can get three times as many parts from a pound of aluminum as from a pound of the other metals.

High Strength—Some aluminum alloys are stronger than structural steel. Aluminum alloys are being used in rugged applications like dump truck bodies, building structurals and highway bridges.

Good Electrical Conductor—One of the main reasons you see more and more aluminum in cable, transformer windings, switches, motors, capacitors, and bus duct is its conductivity. One pound of aluminum is equal *electrically* to two pounds of copper. This conductivity, plus its light weight, strength, and workability, makes aluminum an important cost-cutter in electrical equipment and systems.

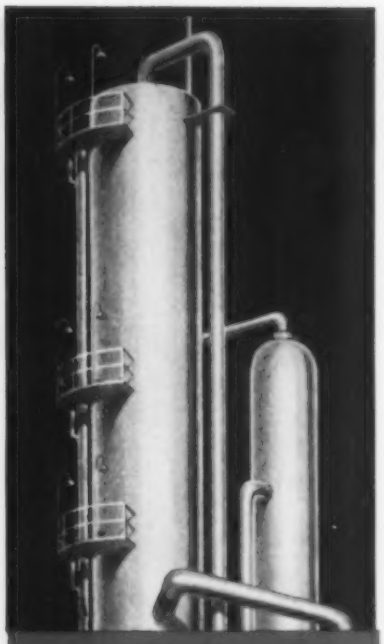
Finish Variety—No other metal can be finished in so many different ways, for so many different effects. You can achieve a brightly-colored or clear finish by anodizing. Aluminum can also be electroplated, painted, porcelainized.

REYNOLDS



Easily Machined and Finished

High Thermal Conductivity



Corrosion-Resistant

because it's versatile

You can finish aluminum by polishing, buffing, embossing, scratch-brushing, spin finishing—by just about any mechanical method. Or you can leave it unfinished, and still have an attractive product.

High Thermal Conductivity—Aluminum conducts heat rapidly and efficiently, thus, it is ideal for air-cooled engines, heat exchange elements, evaporators, cooking utensils. Another characteristic of aluminum is its low emissivity—it retains heat, making it more efficient for air ducts.

Corrosion-Resistance—Aluminum won't rust. But equally important is the fact that aluminum will keep its brightness and strength when handling many chemical agents that attack other metals. This is why so much aluminum piping, jacketing, tanks, vessels, and structurals are used in the chemical and petroleum fields.

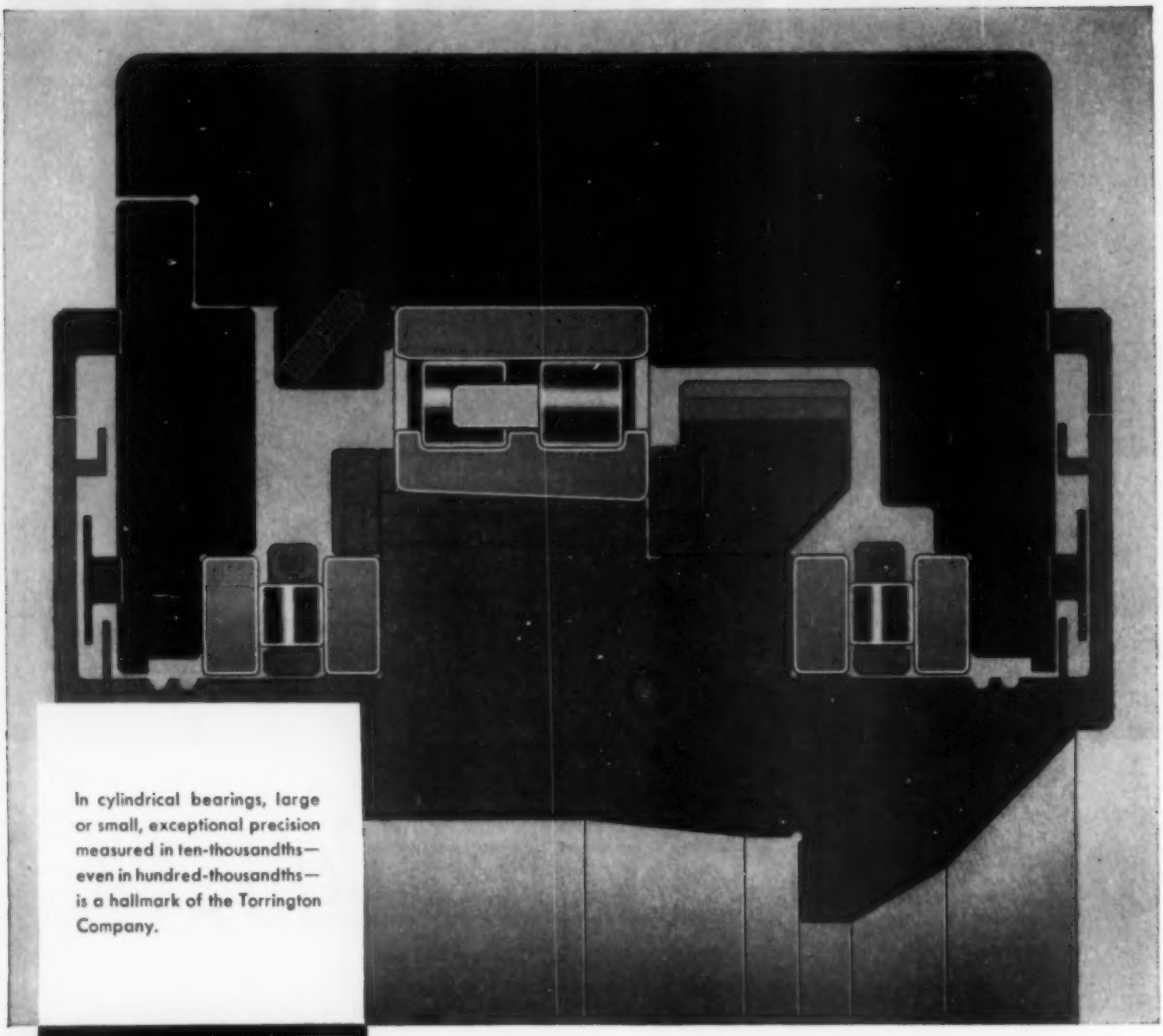
Get the details on all of the characteristics and properties of aluminum and its alloys, and on how it can improve your products, cut your costs. Contact the Reynolds Design and Engineering Service, through your local Reynolds office.

Reynolds Metals Company, P.O. Box 2346-HN, Richmond 18, Virginia.

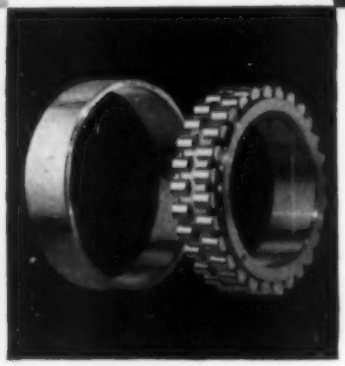
Watch Reynolds new TV shows
"WALT DISNEY PRESENTS" and **"ALL-STAR GOLF"**
every week on **ABC-TV.**

ALUMINUM

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM



In cylindrical bearings, large or small, exceptional precision measured in ten-thousandths—even in hundred-thousandths—is a hallmark of the Torrington Company.



Turns true within three "tenths"!

To the engineer, that means these large Torrington Cylindrical Roller Bearings have a total radial runout of only .0003″—three ten-thousandths of an inch! To anyone, that means ultra-precision.

These are spindle bearings custom-built for Gisholt Machine Company's center drive lathe. The tapered bore, two-row radial roller bearing is 44.2500″ OD, capacity 189,000 pounds at 100 rpm. Face runout is held to .0005″. Each of two cylindrical thrust bearings used is 38.4700″ OD, capacity 105,000 pounds at 100 rpm. Diameter of rollers in any one bearing is held within one-half "tenth"—.00005″.

This close approach to perfection is made possible by specialized equipment and superior workmanship, which go into the manufacture of every Torrington Bearing, large or small. Of course, not every application requires such ultra-precision. But each bearing requirement is given the extra measure of care that makes Torrington quality a byword in industry. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

2 NEW OHMITE® Precision Resistors

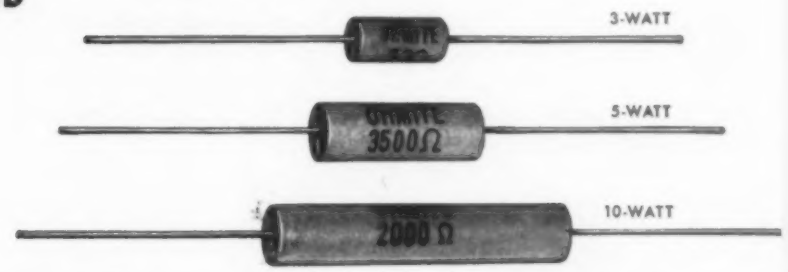
exceed Military Specifications

provide Low Temperature Coefficient of Resistance

NEW MOLDED WIRE-WOUND POWER TYPE

BULLETIN 153

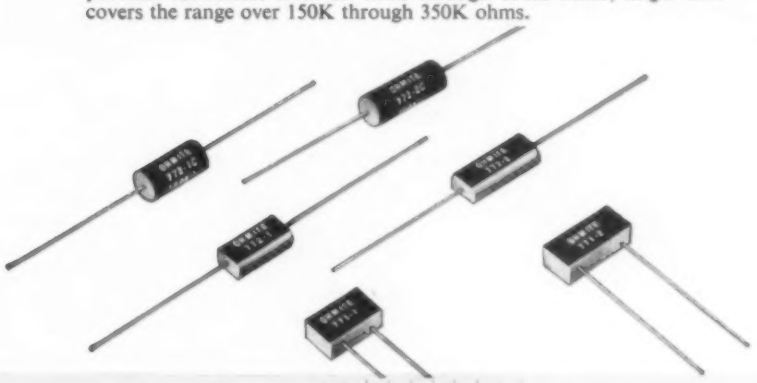
Ohmite Molded Precision Power Resistors are exceptionally high-quality units providing excellent performance. They are wound in a single layer on ceramic cores. Temperature coefficient of resistance is low, 0 ±20 ppm/°C. Tough, molded, silicone-ceramic covering—abrasion and moisture-resistant. Insulated units with high dielectric strength. Wide selection of resistance tolerances: 0.1%, 0.25%, 0.5%, 1.0%, and 3.0%. Uniform size—ideal for automated assembly. Designed to meet MIL-R-26C. Maximum resistance: 3-watt, 10,000 ohms; 5-watt, 25,000 ohms; 10-watt, 50,000 ohms.



NEW METAL-FILM TYPE

BULLETIN 155

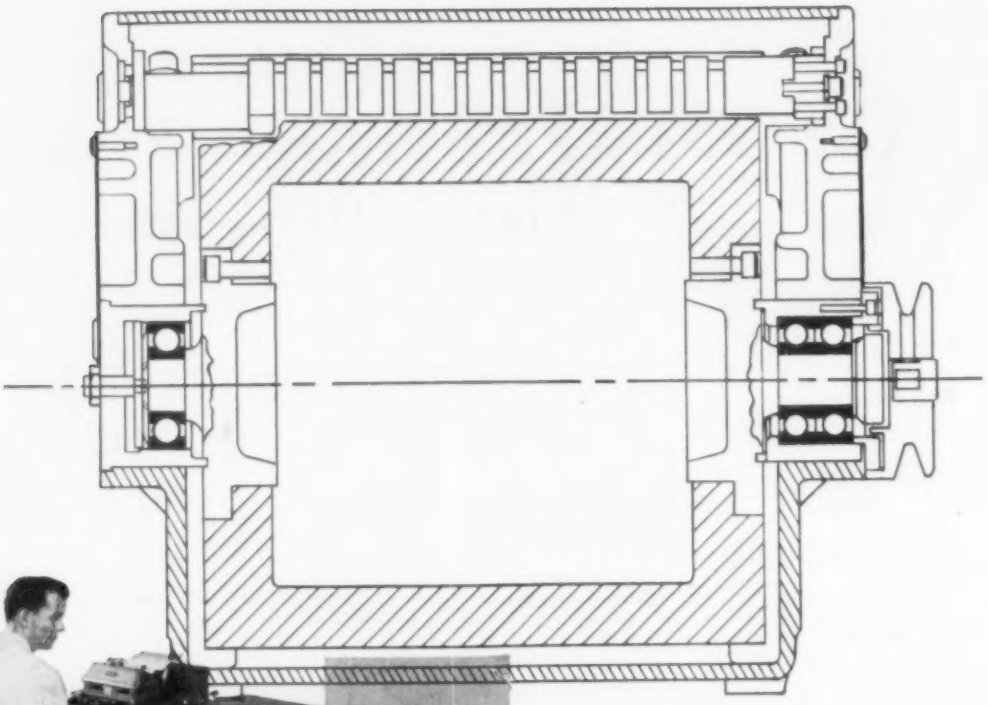
Ohmite RITEOHM® Metal Film Resistors feature full ¼-watt rating at 150°C ambient. These new units may be used at *full rated wattage* in higher ambients than other types of precision film resistors. Rated at ½ watt at 125°C. Excellent high-frequency characteristics; standard temperature coefficient is 0 ±25 ppm/°C over a wide temperature range of —55°C to +190°C. A T.C. of 0 ±50 ppm/°C is also available at lower cost; long term load and shelf stability. Resistance range: two sizes provide over-all range of 25 ohms to 350K ohms. The smaller unit provides resistances from 25 ohms through 150K ohms; larger unit covers the range over 150K through 350K ohms.



RHEOSTATS • RESISTORS • RELAYS
TAP SWITCHES • TANTALUM CAPACITORS
R. F. CHOKES • VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3611 Howard Street, Skokie, Illinois

Be Right with OHMITE® QUALITY Components



"NO ROOM FOR ERROR"

in design of desk-size LGP- 30 digital computer!

Precise performance assured in Librascope's Fafnir-equipped LGP-30

Small as a desk, but it "thinks big"! No less than 4096 words can be recorded on the magnetic memory drum of the new Royal Precision Electronic Computer LGP-30. Moreover, this compact unit, made by Librascope, Inc., a subsidiary of General Precision Equipment Corporation, can be rolled where it's needed and plugged into any conventional wall outlet.

At the heart of this versatile computer, Fafnir super-precision type ball bearings maintain the precise alignment and high sensitivity required of the drum component. Counterbored to take a wide range of thrust, and radial loadings, these bearings provide the rigidity, extremely close-running accuracy, and low torque essential in this exacting application.

Fafnir's contribution to the development of the LGP-30 is another case history example of the high caliber and comprehensive scope of Fafnir design engineering services available to *you*. Take advantage of it when you have a bearing problem. The Fafnir Bearing Company, New Britain, Conn.

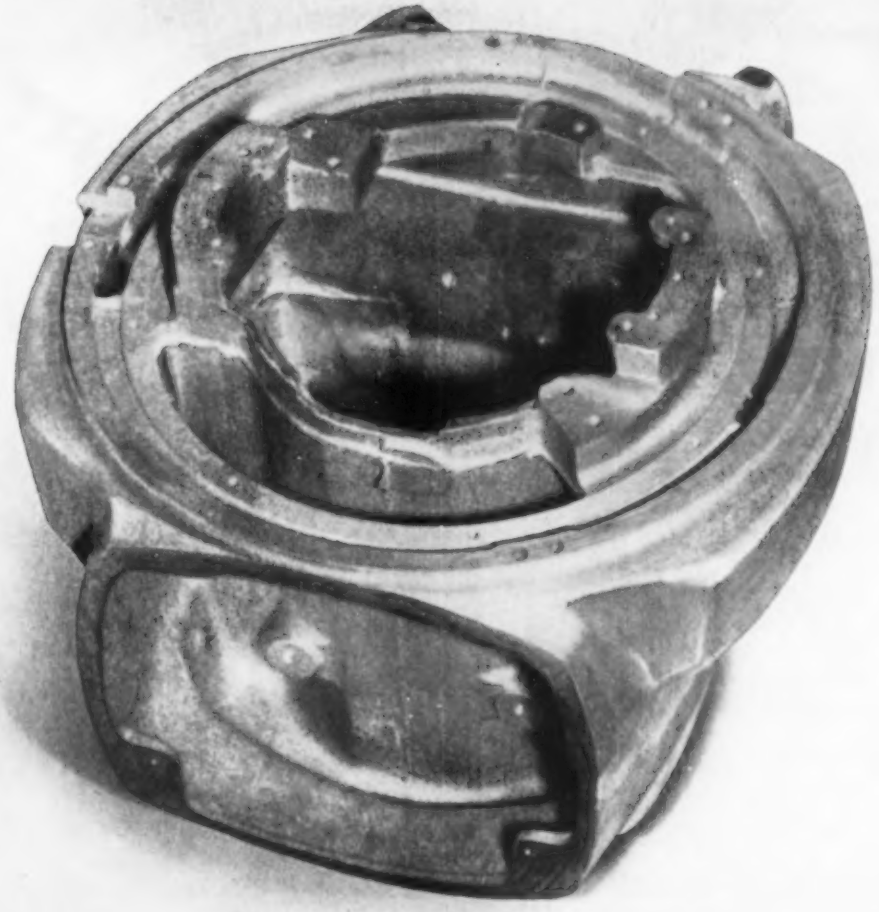
The new Royal Precision LGP-30 is a serial, single address, fixed point binary, stored program digital computer featuring simplified design and ease of operation. The unit is designed to make computer use economical and simple enough for more widespread application.

Fafnir Super-Precision Type Ball Bearings are used in duplex pairs, mounted back-to-back, at the pulley end of the LGP-30 memory drum, and singly at the opposite end. These preloaded, angular-contact bearings, equipped with composition or bronze retainers, are widely used in precision-built mechanisms.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

Pay less for more strength! Tenzaloy the self-aging aluminum alloy needs no heat treatment! If your aluminum castings are too large or too intricate for heat treatment, if your heat treating facilities are limited, if you need superior strength than you get from ordinary heat-treated alloy demand "Federated Tenzaloy" developed by Federated to meet the need for a superior aluminum alloy that ages at room temperature. Tenzaloy eliminates rejects due to warpage, expansion, and internal stresses caused by quenching. Tenzaloy finished properties are stable, proved by conclusive test data over a ten year period. No special foundry techniques are required. No fluxes. Castability is excellent with sand cast and plaster molds and many permanent molds. Tenzaloy will not "grow," produces corrosion-resistant castings with excellent polishing characteristics and anodizes clear white. Write for Tenzaloy Bulletin No. 103. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

FEDERATED METALS DIVISION OF

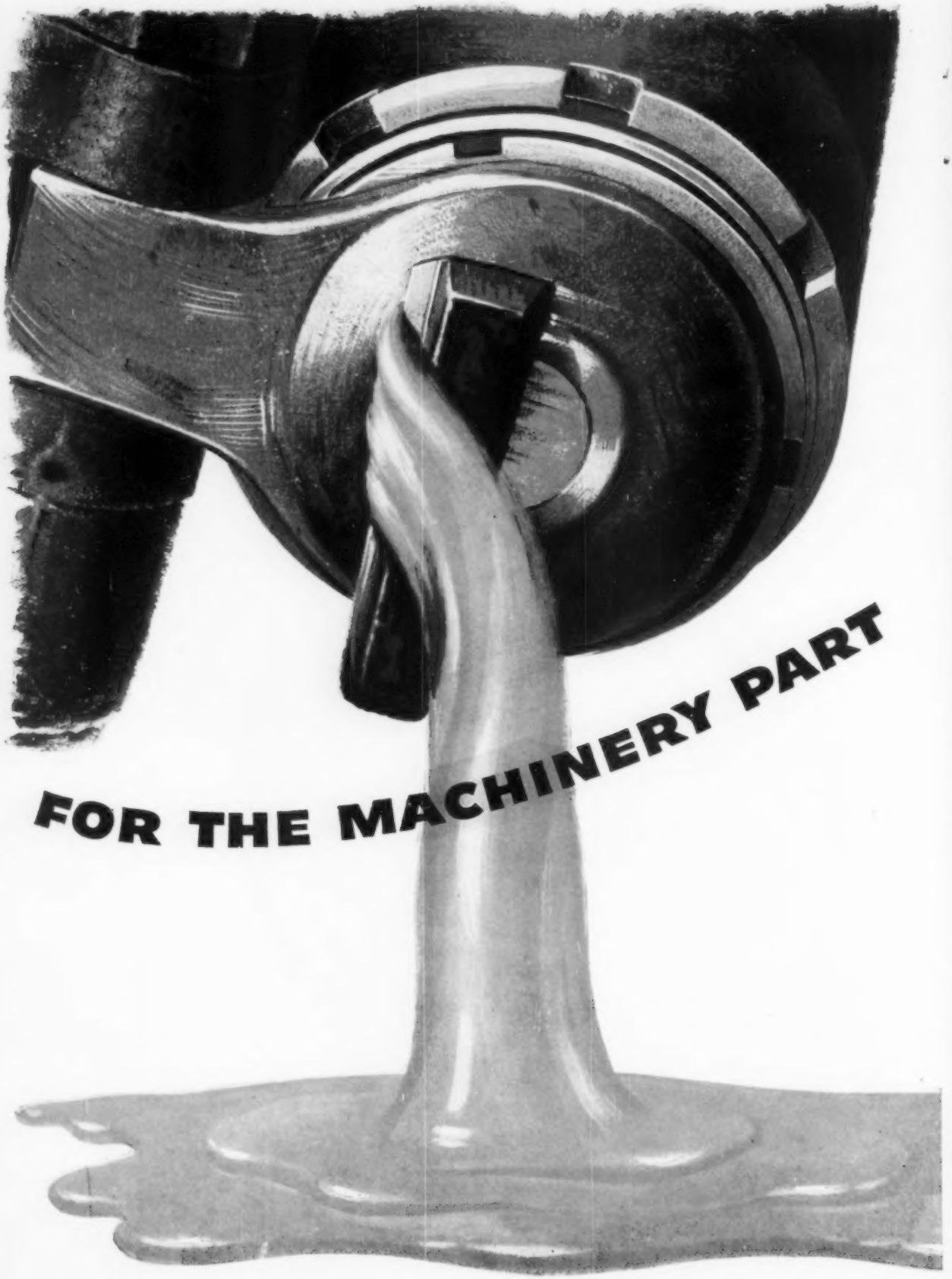


ASARCO

AMERICAN SMELTING AND REFINING COMPANY

TENZALOY is one of a complete series of Federated aluminum casting alloys. A new plant in Alton, Ill. will soon be in production to satisfy the requirements for Tenzaloy in the mid-west.

58-28


FOR THE MACHINERY PART

Alton, Ill. will soon be in production to satisfy the requirements for Tenzaloy in the mid-west.

58-28

THAT TAKES THE BEATING

A cut-off knife made of HAYNES STELLITE alloy No. 19 slices through molten glass at 2200 deg. F. Despite the intense heat of the glass being molded into tumblers, and the severe erosive action of the glass on metal, the cut-off knife maintains a 0.015-in. clearance between itself and the mold ring . . . *far longer than any other material ever used.*

HAYNES Alloys *will do the job!*

Are you looking for a tough metal part to improve your machinery? It will pay you to look into HAYNES alloys. There are more than 15 from which to choose, including HAYNES STELLITE cobalt-base alloys, HAYNES iron-base alloys, HAYSTELLITE cast tungsten carbide, and HASTELLOY nickel-base alloys. They are available as castings, forgings, completely fabricated parts, or as sheet and bar stock. Parts can be furnished machined or ground to specified size and finish.

Our engineers will help you pick the right HAYNES alloy to resist many conditions of wear, heat, or corrosion.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

UNION CARBIDE

The terms "Haynes," "Haynes Stellite," "Hastelloy," "Haystellite" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

TYPICAL "HAYNES" ALLOY MACHINERY PARTS

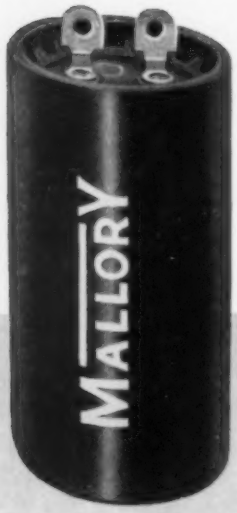
Tough, long-lasting metal-cutting saws over 20 inches in diameter, made of HAYNES STELLITE alloy sheet, slice the tops off copper ingots.

Steam atomizer fuel burner nozzles of HASTELLOY alloy C resist corrosive agents and erosion for months, retaining essential contours.

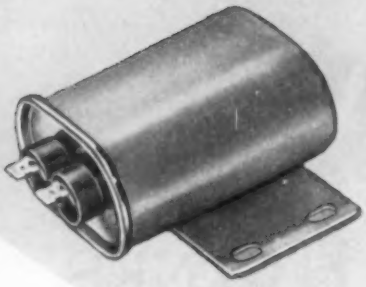
High-temperature strength and corrosion resistance of diesel combustion chambers made of HASTELLOY alloy C make them "good for life of the engines."

For Longer Service Life...

Motor Start with Built-in Bleeder



Motor Start



Motor Run

Specify

Mallory

Motor Start and Run

Capacitors

MALLORY—pioneer in capacitors—manufactures a complete line of dependable motor start and motor run units for every standard requirement.

Newest cost-saving additions to the line are Mallory motor start capacitors featuring a built-in bleeder resistor, deposited on the top plate between the terminals . . . and oil filled motor-run capacitors in new ratings at 165VAC which make possible reduced run capacitor costs.

Mallory Electrolytic Motor Start and Paper Dielectric Motor Run Capacitors are extremely dependable. They offer longer service life and indefinite shelf life . . . feature moisture-proof construction . . . and offer a complete selection of capacity and voltage ratings and physical sizes.

The Mallory Representative will be glad to supply any required data, or arrange for an application engineering discussion to help meet your specific needs.

Serving Industry with These Products:

Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical — Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more...get more from

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

CIRCLE 116 READER SERVICE CARD

CIRCLE 117 READER SERVICE CARD→

DE LAVAL
IMO PUMPS

are now more versatile than ever

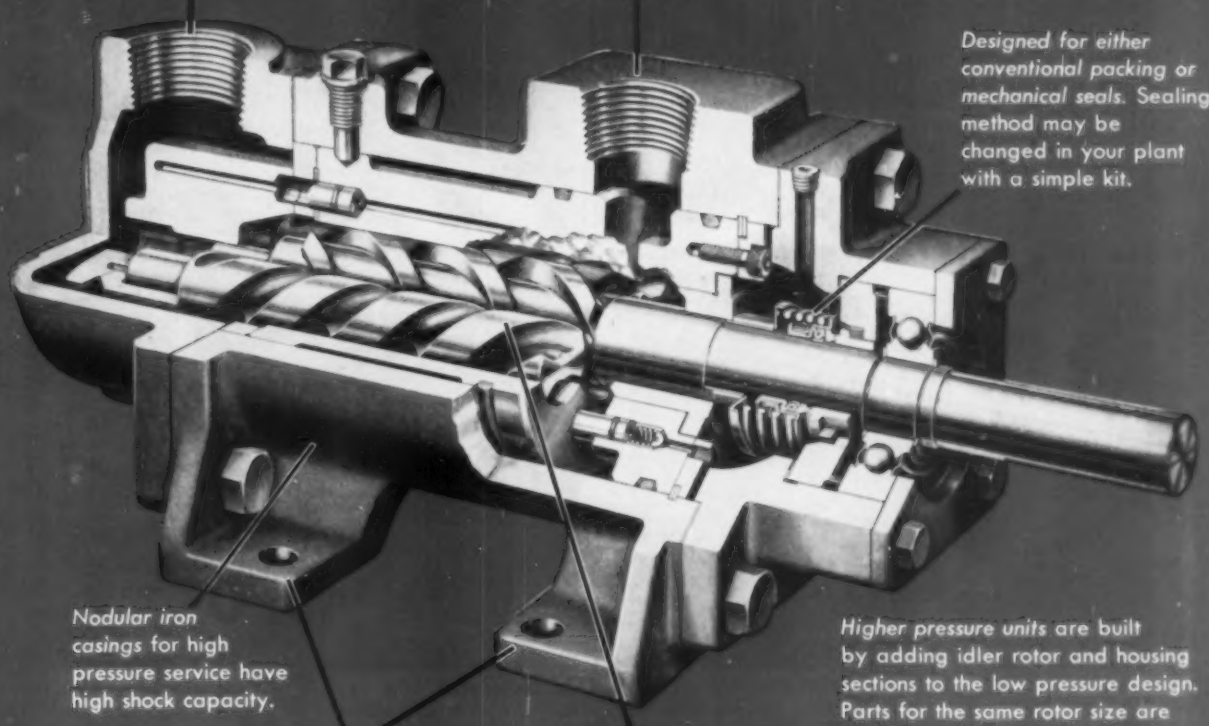
De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.



Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

Nodular iron casings for high pressure service have high shock capacity.

Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Internal parts are designed as a package so that units can be built into your machines.

Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

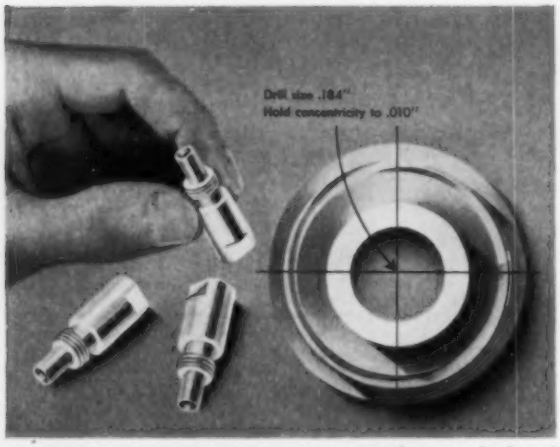
DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

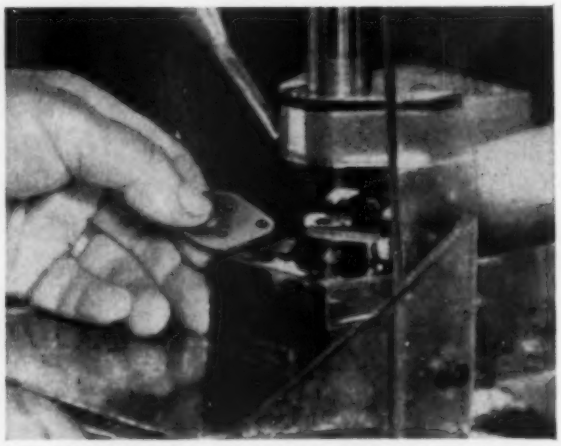
801 Nottingham Way, Trenton 2, New Jersey

BL 418

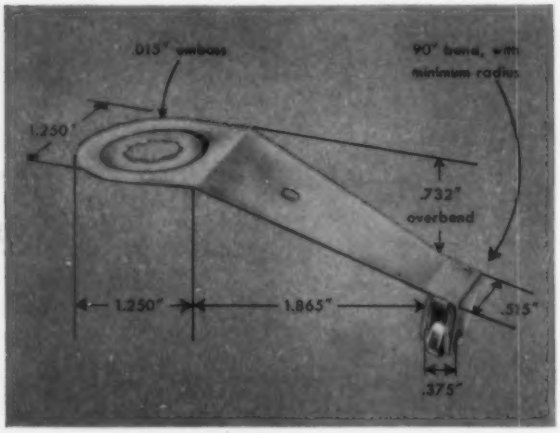
THE RIGHT METAL often costs less, may give you surprising savings in fabricating time and cost. Talk to the Man from Anaconda about matching metals to your specific needs, today.



BRASS ROD WITH A SLIGHTLY HARDER CORE than standard rod eliminated rejects (that had run up to 15%) for M. J. Grass Screw Machine Products Co., Buffalo. With standard rod, in drilling a deep hole on multiple spindle machines, the drill tended to wander past the concentricity tolerance.

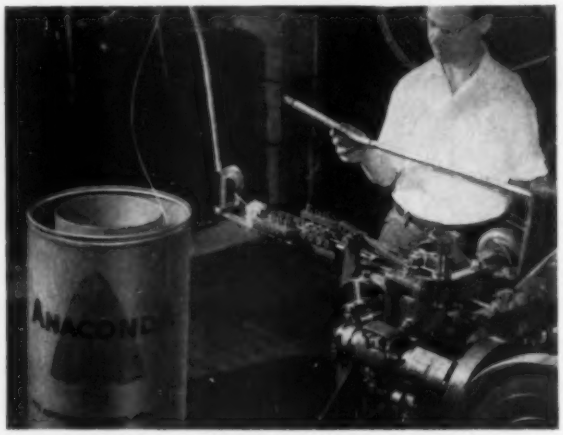


LEADED COPPER STRIP (machinability rating 80%; conductivity, 99% IACS) boosted production, cut over-all costs 25% for Truelove & Maclean, Waterbury, Conn., in making power transistor bases. Adequate production with ordinary electrolytic copper would have called for new equipment investment.



SUPERFINE-GRAIN PHOSPHOR BRONZE eliminated fractures in forming complex variable voltage tap springs (above) used in Lionel's Trainmaster transformers. Lionel had considered substituting a costlier alloy but Duraflex* did the job at no extra cost.

*Anaconda superfine-grain phosphor bronze.



PAY-OFF BARRELS with big coils of brass wire cut down-time 90% at wire forming machines for West Haven (Conn.) Buckle Co. Machines making surgical buckles had used light coils for free pay-off; new coils had to be fed in about every hour.

From a base of 93 standard alloys, The American Brass Company can provide an almost unlimited number of combinations of useful properties. It may take only a minor variation in fabrication or annealing in your present alloy to make the metal fit your need exactly. Or you may need another alloy—perhaps one that is less familiar to you because it has had such highly specialized application. So when new or unusual problems arise, ask for the help of our Technical Department. See your Anaconda representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

3856

ANACONDA®

COPPER • BRASS • BRONZE • NICKEL SILVER • MILL PRODUCTS

Made by The American Brass Company

open motors for extreme conditions

Save up to 60%!

Here's an amazing advance in motor technology! It's the *Super-Seal* motor line — an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalis that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate an encapsulated stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

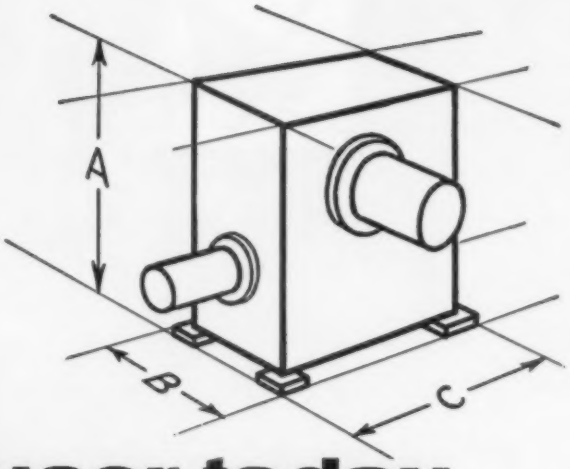
Both of these insulation systems are unsurpassed. Proof? An encapsulated motor ran for hundreds of hours at full load in a 4% brine solution.

Find out more about new economies in motors from your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. *Silco-Flex and Super-Seal are Allis-Chalmers trademarks.*

ALLIS-CHALMERS A-C

A-5802

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

IT'S NEW

IT'S A PUSH-IN NUT

light finger pressure seats it for good!

PATENT PENDING

ROUND HEAD SQUARE HEAD

RECTANGULAR

TABLE OF DIMENSIONS

For use with #8 or #10 screws, finished hole size .290/.281, application thickness .030/.060. Other sizes available soon.

HEAD SIZE	HEAD HEIGHT
7/16" DIA.	.150
1/2" DIA.	.030
1/2" DIA.	.040
1/2" DIA.	.070
1/2" DIA.	.150
1/2" DIA.	.100
3/8" SQ.	.040
3/8" SQ.	.140
13/32" SQ.	.030
13/32" SQ.	.200
3/8" x 37/64"	.060

This new Dot Nylon Push-in Nut offers additional design and performance advantages over our currently available plastic snap-in nuts. These advantages are:

(1) Straight legs permit easy insertion in square, punched holes and do not distort the holes even in soft aluminum or thin-gauge steel. (2) Burrs do not impede the nut or prevent proper seating. (3) Tapered screw hole causes legs to spread when screw is inserted and results in greatly increased pull-out resistance (see drawing A).

Ordinary sheet metal screws cut clean, strong threads in the molded nylon and the nut is both re-usable and highly resistant to vibration.

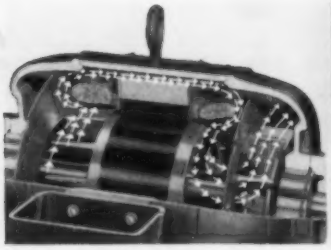
Used as a nut or as a spacer, Dot's Nylon Push-in Nut has wide application in all products where sheet metals or plastics are employed. They can be supplied with a moisture resistant sealer and special nuts can be designed to your specifications if volume warrants. Currently available in eleven sizes. Full information on request.

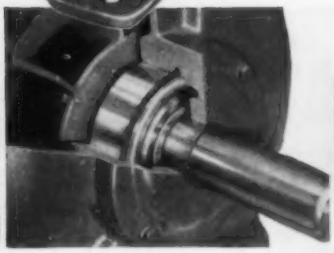
CARR FASTENER COMPANY

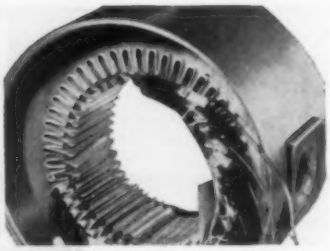
Division of United-Carr Fastener Corp., Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

Robbins & Myers
helps







Highly efficient dual-sweep ventilation

Tandem fans, one pushing and one pulling, cool motor from end to end . . . air-wash field coil ends . . . eliminate "hot spots" . . . greatly prolong motor life!

Fully sealed prelubricated bearings

Run in double-width races . . . have extra-large lubricant reservoirs . . . seldom need re-lubrication . . . are quickly, easily inspected by removing cover plates!

Life-prolonging *Mylar insulation

Has excellent dielectric qualities . . . resists tearing and aging . . . assures virtually permanent protection. Rag paper backing cushions against abrasions and punctures!

* DuPont registered trademark

MOTOR STAMINA

DoALL machines

saw their way to success!

DoALL Contour-matic Band Machine

The DoALL Company equips its versatile Power Saws and Contour-matic Band Machines with sturdy, dependable R&M motors. These motors are precision-built, with ample reserve power that helps DoALL achieve record-breaking cutting rates while working at greater feed and speed pressures.

In thousands of DoALL-equipped plants, R&M motor stamina has proven itself. R&M motors take toughest DoALL jobs in stride—powering their new Demon high-speed steel cutting tool in the machining of harder-to-cut tough new alloys. DoALL versatility depends on reliable power to saw, file, grind or polish all materials. The same strong R&M motor also drives the machine's hydraulic and air pumps, providing smooth power for automatic stock feeding, work table positioning, etc.

If your product requires heavy duty motors designed for faster, more versatile production, plus top dependability, Robbins & Myers can help you.

Contact your R&M representative or write today for Bulletin 520-PRE

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

R&M builds motors from 1/200 to 200 horsepower

Formability—In days of old, when knights were bold, they also were smart. When their very lives depended on a tool or a weapon, they made sure it was made from steel. It could be a great claymore, hefty enough to behead a horse; a bright suit of armor that would turn the Saracen's arrow; or an ornamental castle gate, strongly made to frustrate the assassin.

They wanted steel because it was strong. They could *use* it because it was formable. Truly, there is no economical metal in all the world that can approach steel's combination of strength and formability.

With the near-magic of heat treating, you can soften steel and form it, then harden it to make it strong, then temper it to make it tough. Or form it cold. Use bending, flanging, deep drawing, spinning, cold heading, die drawing, rolling, wiper forming, draw rolling, stretch forming or bumping. In fact, it's hard to imagine any forming operation that cannot be performed on steel.

Fortunately, there are hundreds of different kinds of steel; and they all act differently in the fabricating shop. Everything you do to steel alters its *forming* properties, and every forming operation alters its physical properties.

The aim of the product designer is to find a steel that can be properly formed, that has the right strength, toughness, corrosion resistance, weldability or other characteristics required . . . at the most favorable cost. If you have a design problem and the comptroller is looking over your shoulder, take hope from this idea: there is one "best" steel for any design application. You can be sure of finding it among the great family of USS Design Steels: Carbon, High Strength, Alloy and Stainless Steels.

If you need help in making your selection, ask a company that has produced well over a billion tons of steel, and has spent hundreds of millions of dollars to learn more about this most versatile of man's metals. Of course that means United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

STEELS FOR DESIGN

Lower Left—Problem: Build a power shovel dipper stick with greater strength and shock resistance. Solution: Bucyrus-Erie Company designed a tubular stick made from USS "T-1" Constructional Alloy Steel. Payoff: The "T-1" Steel plates were easily cold-formed into a tube and butt welded. The tubular design and stronger steel assured great strength and shock resistance, and easy fabrication.

Lower Middle—Problem: Produce strong, heat resistant, corrosion resistant jet engine rings—*economically*. Solution: Alloy Manufacturing Company carefully selected a grade of USS Stainless Steel. Payoff: The rings resist heat and corrosion and they are economically roll-formed because the Stainless Steel is formed on "carbon steel rated" equipment.

Lower Right—Problem: Design a pressure tank that is just as strong but lighter than conventional carbon steel tanks. Solution: Manufacturer selected USS MAN-TEN High Strength Steel. Payoff: MAN-TEN's greater strength (50% higher yield point than carbon steel) permitted design of a thinner-walled tank that is 24% lighter. And because MAN-TEN is highly formable, the tank is economically produced by cold press forming of circular blanks into seamless shells, 29" in diameter and 24" deep.

USS, "T-1" and Man-Ten are registered trademarks

For thermal protection our choice is KLIXON Motor Protectors. Built-in overheat protection has been an integral feature in over 1,000,000 WASTE KING disposers.

Waste King Corporation

Proof again that

KLIXON PROTECTORS

safeguard motors against burnouts

"Imperial Hush" food waste disposer, manufactured by Waste King Corporation, largest builder of domestic and commercial garbage disposers, takes the mess out of the kitchen and washes it down the drain.

To assure dependable operation of its units and to safeguard the motors from burnout, Waste King uses motors equipped with KLIXON Inherent Overheat Protectors in its disposers as well as in its dishwashers.

The reason . . . their experience proves that KLIXON Protectors can be depended upon to produce maximum motor performance with minimum failures under abnormal operating conditions.

Should the motor become dangerously overheated due to overloads, stalled rotor or other causes, the KLIXON Protector snaps the power off. The power remains off until the motor has cooled to a safe temperature and the reset button is manually pushed.

You, too, can obtain maximum overload capacity in the motors that operate your equipment by specifying and using KLIXON Protectors. Their use will reduce maintenance costs, service calls, and repairs and replacements. The additional cost is low, pays for itself over and over by eliminating motor burnouts. For details write for Bulletin MOPR-1.

METALS & CONTROLS CORPORATION

Spencer Division 3811 Forest Street, Attleboro, Mass.

KLIXON®

GENERAL PLATE

Copper Cored Glass Sealing Wire Features a Sound Metallurgical Bond

. . . And Gives You These Advantages . . .

- **Leakproof Seal between Alloy and Core**
- **High Electrical Conductivity**
- **Increased Thermal Conductivity**
- **Coefficient of Expansion Matches Glass**
- **Facilitates Miniaturization**
- **Cuts Costs**

General Plate Copper Cored Alloy Wire (33% copper clad core, 67% glass sealing alloy) gives you three times greater electrical conductivity than solid #52 alloy wire of equal diameter.

This means you can substantially increase the current carrying capacity of your solid sealed leads without going to larger diameters — or, if you have a miniaturization problem, you can reduce sealing wire diameters correspondingly. The sound metallurgical bond between the copper core and outer shell eliminates any air or gas leaks in the wire.

General Plate Copper Cored Glass Sealing Wires are used for better performance in glass-to-metal seals in hermetically sealed devices such as switches, relays, coils, controls, vacuum tubes and semiconductors.

They are available in #52 alloy, Type 446 stainless, low carbon steel, Kovar* and other glass sealing alloys. Write for Bulletin IND-15.

For details on the complete line of General Plate Clad Metals, ask for a free copy of GP-1 Catalog.

*T.M. Registered Carborundum Co.

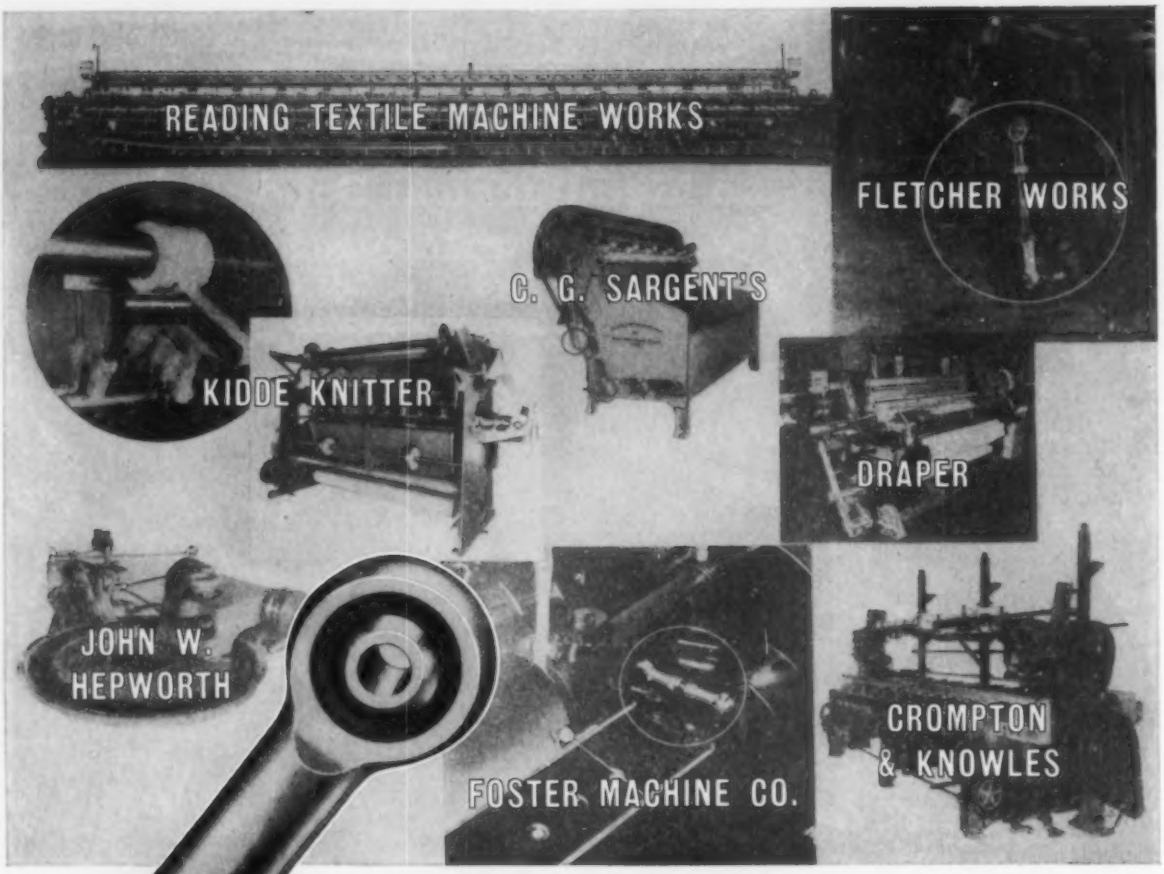
You Can Profit by using General Plate Clad Metals

METALS & CONTROLS CORPORATION

General Plate Division

1011 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA

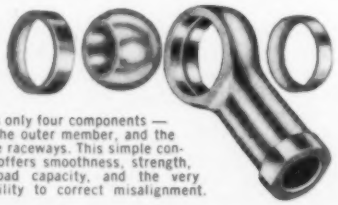


Label loom, Knitting machine, Coning machine, Loom Manufacturers specify . . .

HEIM *Unibal*® SPHERICAL BEARING ROD ENDS

The textile industry has found literally hundreds of uses for the versatile Unibal Rod Ends. They correct inherent misalignments on the *Crompton & Knowles* Narrow Fabric Loom. On the *Draper* X-2 loom, one Unibal now takes the place of several parts formerly used. *Fletcher* uses Unibal to correct misalignment in the shuttle motion of a label loom. The *Foster* Pineapple Coning Machine uses Unibal for flexibility, freedom of motions, and ruggedness to withstand vibration. The *Hepworth* Sweater-Looper uses Unibal at both ends of all drive rods. The *Kidde* Knitter which produces lace edgings, veilings, etc. uses Unibal Rod Ends as suspension hangers. Unibal is used in the covering knife motion on the *Reading* Full-Fashion knitting machines. On the *C. G. Sargent* Automatic Feeder which combs out the wool, Unibal improves the operation of the driving mechanism.

The common function of all push-pull rod assemblies is the transmission of force and motion from one machine component to another. A Heim Unibal rod end at one or both ends of the rods in an assembly assures smooth, trouble-free operation. The Unibal device can be used for many other mechanical functions, however, and its versatility makes it a welcome accessory in solving many difficult support problems, such as the suspension hangers as used on the Kidde Knitter.



Unibal has only four components — the ball, the outer member, and the two bronze raceways. This simple construction offers smoothness, strength, greater load capacity, and the very useful ability to correct misalignment.

Heim bearings are sold through the country's leading bearing distributors. Write for complete catalog and/or engineering help.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

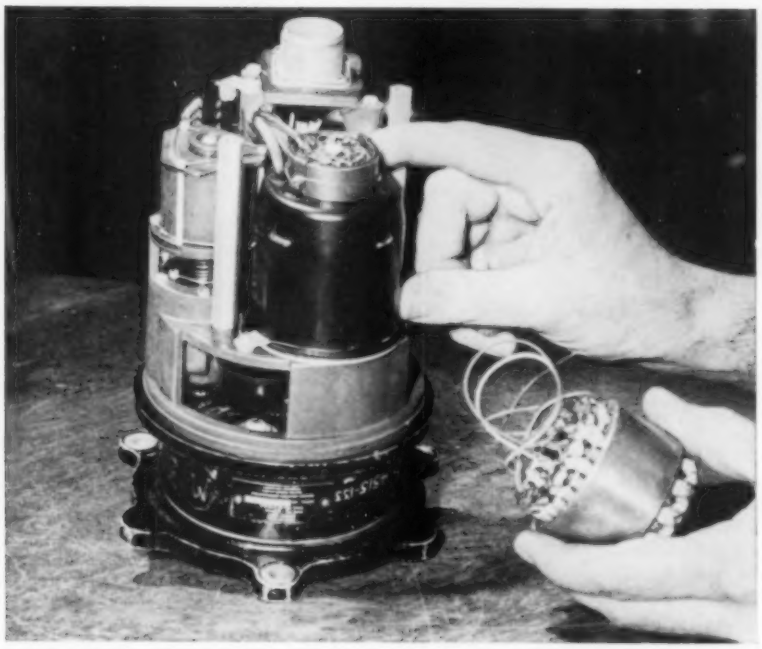
CIRCLE 126 READER SERVICE CARD
CIRCLE 127 READER SERVICE CARD→

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 56



MORE POWER PER POUND

You can now drastically reduce a motor's size and weight without sacrificing either reliability or service life. How? By specifying Dow Corning "Class H" silicone insulation. Here's how it worked for United Airlines:

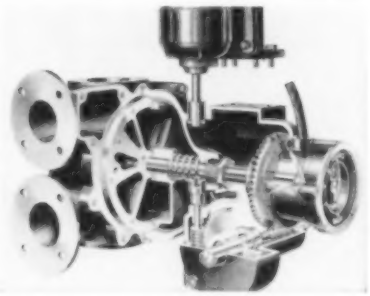
Most United airliners are equipped with automatic pilots that have three servo-motors to actuate rudder, elevator and ailerons. Originally designed for a rated life of only 1000 hours, motor life was deliberately sacrificed to attain absolute minimum size and weight.

Replacing or reinsulating these servo-motors every 1000 hours was costly . . . meant an almost constant program of replacement and repair.

To increase the life of these motors, United Airlines changed from the originally specified Class A insulating materials to Class H insulating materials. Whenever a servo-motor was scheduled for replacement or repair, windings were replaced and a silicone insulation system used. Immediately, the rate of replacement fell off—savings are estimated by United Airlines as being $3400 a year.

Windings impregnated with Dow Corning 997 Varnish as long ago as 1953 still look good as new and the glass-reinforced silicone rubber slot liners also show no appreciable deterioration.

Economy and performance like this account for the growing popularity of silicone insulation in equipment designed for aircraft, missiles, and countless other applications where dependability in service, long life and low-cost operation are deciding factors. *No. 571*



Found: A Lubricant That Lasts!

Frequently, all you need do to minimize maintenance and assure longer service life is specify a silicone lubricant. Here's a specific instance from The Permutit Company, manufacturer of water conditioning equipment.

Faced with the problem of lubricating rubber and bronze parts in the multi-port valves of their water conditioning equipment, engineers at the Permutit Company chose a Dow Corning silicone compound over petroleum greases. Here's why:

(1) Highly water-repellent and long lasting, the silicone compound provides an effective, leak-proof seal between the two mating faces; (2) more inert than organic greases, the silicone compound does not react with or contaminate chemicals passing thru the valves; (3) unlike most organics, the silicone lubricant does not attack the hard rubber slides; (4) the compound protects bronze against corrosion.

This stable silicone compound retains near-constant viscosity over a temperature span ranging from —40 to 400 F. No wonder plug valves, control valves, flow meter bearings, pump packings, plugcocks and other assemblies all function more efficiently and last longer when lubricated with silicones. The silicone compound cited in this application is Propocone distributed by Quackenbush and Sons, 17 Clark Street, Paterson, N. J. *No. 572*

Sealing at the Jet Stream Level

Even in the bitter cold encountered at "jet stream" altitudes, Silastic®, the Dow Corning silicone rubber, stays elastic and maintains an effective, positive seal.

General Precision Laboratory produces a military air navigational system known as the AN/APN-66. Considered by many to be one of the most advanced air navigational systems in use today, it employs the "Doppler effect" to *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

SILICONES IN THE SPOT LIGHT!

Silicones improve the performance of many mass-produced consumer items, often without accessory parts and assemblies that might otherwise be required. Illustrating this point are Westinghouse's new Colortone spot and flood lights.

Combining light bulb and glass lens, these brilliantly-colored Westinghouse lamps require no reflectors. Consequently, when used outdoors, the lamps are completely exposed to the elements. The colored lenses absorb heat so readily that they sometimes build up temperatures to 250 C. As a result, a few cool raindrops or snow flakes could easily crack the lamps.

Westinghouse engineers solved this problem easily and inexpensively by coating the lenses with an invisible film of Dow Corning silicone resin. This silicone coating keeps rain from wetting the lamp surfaces. Instead, rain forms into droplets that run off or vaporize on contact.

The tough silicone film is indifferent to heat, weathering and water. It stays on and protects long after organic coatings would have oxidized or washed away. Sprayed on, the silicone coating is cured simply by turning on the light, and it lasts for the lifetime of the lamp. *No. 573*

SILASTIC *(Cont.)*

measure the frequency shift in the echoes of its own radar to determine ground speed and drift angle—give pilots their exact location.

To maintain a suitable environment at high altitudes, all the major components of the system are housed in special pressurized "black boxes" hermetically sealed with Silastic. Silastic is also used to seal the AN connectors penetrating the boxes. Silastic *sponge* is used to cushion vacuum tubes against shock and vibration.

Silastic was specified as the best material for these jobs because its low compression set and retention of rubbery qualities at temperatures down to —130 F assure trouble-free performance under all conditions. In addition, this silicone rubber has high dielectric strength and is exceptionally resistant to ozone and corona. These unique properties assure maximum reliability and minimum maintenance.

Using this system, military pilots can hitch a "free" ride on the jet stream—a fast current of air at 35,000-40,000 feet traveling from west to east at speeds up to 200 miles per hour. *No. 574*

new literature and technical data on silicones

Silicone Insulation — Its Usage and Future for Power Transformers. This article from INSULATION reviews tests and developments, gives details about the use of silicones in transformers, compares transformers, and cites future and possible trend of dry-type transformers. *No. 575*

Producers of end products made with paper and paperboard coated with a Syl-off silicone anti-adhesive coating are listed in a new source of supply sheet. Included are manufacturers of boxes, board, and containers; camelback cores; drums; multiwall bags; and cotton and nylon liner fabrics. *No. 576*

Silicones as Dielectrics provides design engineers with a convenient selection guide to the silicone products most adaptable to particular applications—ranging from electronic components and assemblies to power distribution equipment and motors. Send for this 12-page, fact-filled, easy-to-use reference. *No. 577*

Dow Corning's Reference Guide gives you a complete 16-page reference to silicone products for all industries. You'll find information on defoamers, rubbers, release agents, packaging materials, lubricants, protective coatings, electrical insulation, and a variety of other engineering materials that you can use to make good products better. *No. 578*

Rubber From Rock reveals a number of ways you can use silicone rubber to improve performance and design of mechanical and electrical equipment. It's a full color sound movie that explains how Silastic, the Dow Corning silicone rubber, is made from quartzite. It demonstrates how parts fabricated from Silastic retain rubber-like properties from —130 to 500 F in automotive, aircraft, and industrial applications. *No. 579*

Pressure sensitive silicone tapes stick to anything, through hot or cold; are water repellent; have high dielectric strength; and are not affected by corrosive chemicals. A folder is available to help you choose the tape best suited to the needs of your product. *No. 580*

Dow Corning silicone fluids provide a number of practical advantages in a variety of mechanical units. The fluids provide reliable, uniform performance in viscous damping, springing, coupling and similar related mechanical applications. An eight page engineering guide provides a convenient reference to the properties and uses of these versatile fluid media. *No. 581*

Dow Corning Corporation, Dept. 8611, Midland, Michigan

Please send me: 571 572 573 574 575 576 577 578 579 580 581

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DEVELOPMENTS TO WATCH...

Coatings that will insulate electrical wire . . .

. . . over the full range from −85 F to 1500 F, are being sought by Wright Air Development Center, and interim reports are encouraging.

There are now organic-ceramic formulations that are serviceable to 1300 F at least, and new inorganic compounds—notably the borosilicates—promise to go the full range. They show the required dielectric properties at room temperature, apparently have sufficient heat resistance, and can be applied and fired by continuous methods.

Also under consideration are such conversion coatings as aluminum for copper. Here, the aluminum is given anodizing treatments for insulation properties. Anodizing presented few problems, Wright Field researchers say, but applying the aluminum to the copper is another story. Right now, the best system seems one which uses a gold flash as an undercoat—not exactly an inexpensive method, but it promises further advances.

A literature survey and preliminary reports from two organizations studying this problem for the Air Force are contained in PB 131 811 and 131 322 (35) and 78 pages respectively), obtainable from Office of Technical Services. Prices are $1 and $2.

Strong, transparent nylon film . . .

. . . said to have unusual resistance to oils and solvents is offered in "developmental quantities" by Foster Grant Co. According to its Grant Polymer Products Div, the new film is so resistant to greases and similar materials, at elevated as well as room temperatures, that it can be heat-sealed even when coated with oil. The film is also water-resistant, but has a relatively high vapor transmission. Sheets up to 36 in. wide and 1.5 to 20 mils thick are now being produced, with a broader range to be offered later.

Solar-energy converters with an efficiency . . .

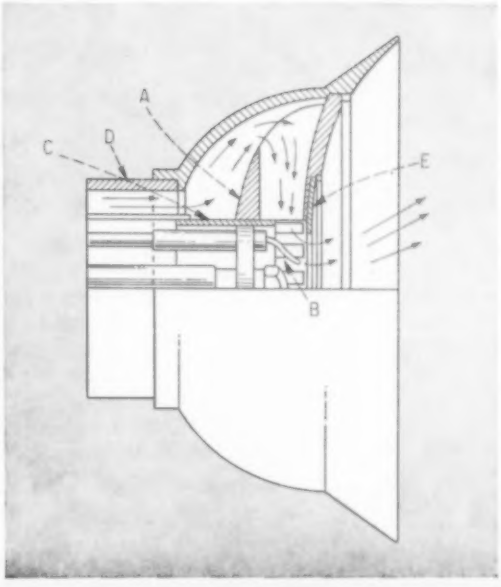
. . . of 10% and an output of 10 watts per lb can now be made, says Air Research & Development Command. These are silicon photovoltaic cells, in production for ARDC by such companies as Hoffman's Semiconductor Div, Evanston, Ill.

Research on cadmium sulfide cells is also beginning to pay off. They are not yet as efficient as silicon cells (present level is about 7.6%), but rapid improvement is being made. Here, Harshaw Chemical of Cleveland is a major contractor.

The research is being monitored by the Aeronautical Research Laboratory at Wright Field.

Improved combustion and fuel economy . . .

. . . are claimed by a Swedish engineer for this new air nozzle for oil-burning equipment. It features a "turbulator" A; and a series of openings *B*, arranged at an angle to the radius. A control sleeve *C* serves as damper by totally or partially blocking these openings ahead of the burner outlet. The air, coming in through pipe *D*, is turned into a "swiftly rotating whirlwind" by the turbulator. This forms a low-pressure area in the center which forces the air flow inwards—with the control member *E* allowing adjustment of the length and cross-section of the low-pressure zone. The air, and therefore the flame, is concentrated near the common focal point of the unit, and the housing acts as a reflector to throw radiant heat back into the combustion chamber. This arrangement, the designer says, makes it possible to control air-oil proportion and air velocity for the most efficient flame.



DEVELOPMENTS TO WATCH...

New anti-wear additives for lubricants . . .

. . . and cutting oils may come from research on the same group of compounds that shows great promise as anti-knock agents in gasoline: the manganese organometallics (*PE—Apr 7, p 5 and May 26, p 30*).

Recent research, says Morton Antler of Ethyl Corp, indicates these compounds can be "very effective in reducing the friction and wear of rubbing metals." Furthermore, he adds, organometallic compounds are able to:

Form protective films without surface attack (in contrast with conventional extreme-pressure lubricants which develop anti-wear films by virtue of sacrificial corrosion of the rubbing surfaces).

Provide lasting protection by deposition of a lubricating film which not only prevents wear while the addition is being used, but also protects surfaces during later operation with other lubricants.

In an interim report to the ACS Div of Petroleum Chemistry, Antler added that hard metals seem to respond to organometallic lubrication better than soft ones. That means, he believes, that surface treatments which increase the hardness of metals may also increase the effectiveness of the organometallics as lubricants.

Incidentally, that classic antiknock compound—tetraethyl lead itself—is also an organometallic, and may turn out to be as valuable a lubricating additive as the other materials mentioned here.

Cemented borides show promise . . .

. . . as cutting-tool materials. But a lot more work remains to be done before they can go to work.

Such is the final report from Armour Research Foundation on a three-year study sponsored by ASTE.

Of the compounds tested, nickel-titanium diboride and iron-aluminum decaboride received the most extensive study, and both showed acceptable hardness. However, problems of brittleness, porosity, and abrasion resistance remain to be solved. Better binders are needed; so are improved processing techniques to achieve the higher densities necessary to minimize mechanical failure.

Says ARF: Further development is required before a satisfactory conclusion can be made as to suitability of these alloys as tool materials.

Copies of the 61-p, plastic-bound report are being made available by ASTE at a price of 50¢ to members, and $1 to nonmembers. It's ASTE Research Report #13 on ARF Project B687.

The future of constant-speed drives . . .

. . . in aircraft will be a short but busy one, says C. W. Helsey, Jr of North American Aviation. The CSD's have now reached full maturity, he believes, will attain "the zenith of their application and development in the next 10 years." After that, he thinks, space flight, new propulsive means, and better methods of energy conversion will start the downward trend. Other predictions:

- 99% of all CSDs used in future aircraft will drive ac generators.
- Transmissions will be fluid-lubricated and fluid cooled.
- The field of usable materials will narrow and center on the tool steels and high alloys, with steel replacing aluminum and magnesium in housings (to reduce thermal expansion problems); metal O-rings replacing elastomers (for greater heat resistance); and hard-faced steel seats and riders taking over from the steel-graphite combinations on rotary-shaft seals while steel bellows replace elastomeric static seals.

Improved synthetic rubbers and plastics . . .

. . . and new coating and dyeing systems are promised by techniques that combine irradiation treatments with heat and catalysts. Instead of trying to make radiation do the whole job, researchers on both sides of the Iron Curtain are now emphasizing a dual approach which, they report, is not only less costly but also more effective.

Among recent achievements reported by USSR scientists at the Geneva Conference on the Peaceful Uses of Atomic Energy: production of white and black-reinforced fluorine rubbers that show twice the tensile strength of non-irradiated material at elevated temperatures; and the new radiation-induced process by which synthetic fibers are coated with anti-static compounds and dyes. (For more news of the Geneva Conference, see *PE—Oct 6, p 10*; and for information on radiation sources, *PE—April 14, p 52*).

—ARG

First Design Look at Studebaker's Lark

Following American Motor's lead, Studebaker-Packard introduces its "compact car" entry into the churning automotive market. Just how small, economical, and unique is it? Product Engineering's Detroit Editor, Felix Giordano, interviewed scores of S-P engineers, salesmen, production people to get the story.

SOUTH BEND, IND.—Studebaker-Packard has officially joined the "smaller-car" bandwagon with introduction of its 108-in. wheelbase Lark model. S-P officials say it came out of "design by committee" – Engineering, Styling, Production and Sales. More important, says S-P, the Lark achieves economy through extensive use of standardized parts and assemblies as well as production-line tooling.

Small in size (sedan models measure 175 in. long; 57½ in. high, 71¾ in. wide), light in weight, the Lark requires only a 90-hp engine at 4000 rpm in the 6-cyl model, and 180 hp at 4500 rpm in the 8-cyl models. The resulting lighter-weight power unit is an improved version of previous S-P engines designed to burn "regular" gasoline.

Internal power losses have been reduced by cutting down the stroke. Two innovations improved fuel combustion: (1) a fuel deflector ring installed between the carburetor and intake manifold prevents formation of droplets on walls of the manifold, (2) new high-turbulence combustion chamber gives better flame propagation in a more compact charge. Engineers say the new chamber yields an extra mile per gallon of fuel.

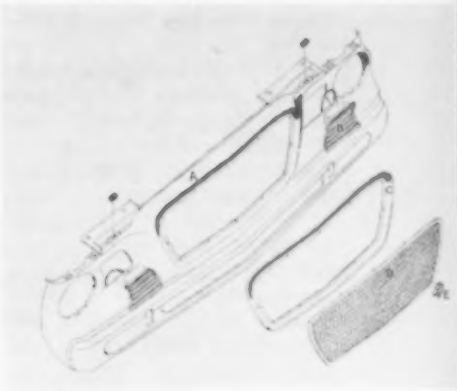
Though a lighter car, the Lark uses large wheels (15 in. instead of the more common 14 in.) together with relatively wide brake drums. Load is only 17.58 lb of car per sq in. of brake in the 6-cyl 4-door sedan, and the even lower 17.15 lb per sq in. of the 8-cyl 4-door sedan—lower than for any other car now on the road, S-P claims.

ECONOMY OF PRODUCTION

The Lark is being manufactured on existing production lines, reworked and to some extent retooled. Design of components for utilizing existing facilities was always a consideration, according to C. E. Gierke, manager of manufacturing engineering. This kept tool costs low.

Limiting the number of models and body types helps cut cost of dies and tools per car, also cuts down-time needed to change from one model to another.

Integrating two or more parts into one reduces production costs, often gives a bonus of added strength and rigidity. The front grille panel, for example, is produced in a single stamping, eliminates a number of assembly operations, cuts down on number of tools needed, precludes the possibility of failure at joints. The panel is designed for easy stamping without recourse to special, more-expensive steels. Savings are in low reject rate, as well as a less expensive set of dies.



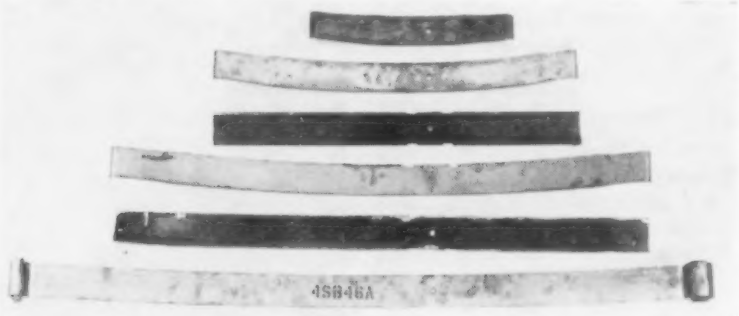
Front grille panel . . . made in a single stamping, reduces cost of production, increases structural strength. (A) front grille panel, (B) parking light and intake-grille assembly, (C) grille trim ring for one model line only, (D) grille for all models, and (E) ornament for all models.

Similarly, the shelf in back of the rear seat has been made integral with the reinforcement of the upper panel of the rear deck—again adding to strength and reducing manufacturing and assembly operations.

Even where parts couldn't be integrated, assembly was designed to perform an additional function wherever possible: The air ducts, welded to the front fender aprons, form box structures that add to the strength and rigidity of the fender assembly; box structure of the trunk provides support for the trunk side walls without need of intricate, expensive reinforcements.

Eliminating the common small-radius curve in the rear light glass reduces cost of the glass without reducing visibility, permits using a rubber weather-seal section that doesn't have to be specially molded. It's easier to make this water-tight, and the increased metal between rear light and

Rear leaf springs assembly drawing and exploded view of wide rear leaf spring equipped with polyethylene interleaves to give permanent lubrication.



side door again adds to strength of the structure.

Standardization of components allows the same part to go more than one place, with possibly one additional operation. An example are the bumpers —the same, front and rear—except that front bumpers get two hole for license-plate mounting. Bumper support bars are exactly the same in all four locations, as are the guards. Front-bumper inner bars are the same for all models. Even the ornaments have been standardized, the same emblem being used on all cars.

FEWER COMPONENTS

Savings have been achieved, too, by simplifying and reducing the number of components. The heater has only two control knobs, one to change fan speed, the other for controlling rate of warm-water flow through the heater radiator and to position the baffle to the defroster. The heater fan has two speeds, obtained by a double-wound motor, eliminating a rheostat in the switch. Reduction in number of knobs reduces assembly costs, makes for a neater dashboard.

Design for ease of manufacturing and assembly is carried on in other parts of the car. Shape of the stop light was chosen to give easier draw on the rear fender. This fender, bolted on from inside the trunk space, is easier to install or repair.

The Lark's frame is of ladder-type box construction. Front suspension is with variable-rate helical springs. The rear rests on wide leaf springs with polyethylene interleaves to give permanent lubrication.

DESIGN BY COMMITTEE

An eye-opening feature of the Lark's design is that so many departments, normally not thought to be associated with the design function, got together with engineers, designers and stylists to create a car that not only meets customers' needs as sales personnel see them, but also satisfies the needs of Manufacturing, Purchasing, Tooling, and even lets the dealer get by with lower inventories of parts.

Result is a new car described by its makers as compact without being small, economical without being austere, comfortable to ride in, and easy to drive, to park and to fit into a modest garage.

LARK SPECIFICATIONS

	6-cyl	8-cyl
Height (loaded), in.	57 1/2	—
Length, in.	175	—
Max width, in.	71 3/4	—
Tread, front, in.	57 3/8	—
Tread, rear, in.	56 9/16	—
Wheelbase, in.	108 1/2	—
Tire size, in.	5.90 x 15	6.40 x 15
Total brake area, sq in.	146.4	172.8
Displacement, cu in.	169.6	259.2
Compression ratio	8.3:1	8.8:1
Horsepower @ rpm	90@4000	180@4500
Torque, ft-lb @ rpm	145@2000	260@2800
Headroom, front seat, in.	36	—
Headroom, rear seat, in.	35	—
Hip room, front, in.	59 1/2	—
Hip room, rear, in.	59	—
Leg room, front, in.	44	—
Leg room, rear, in.	41	—
Shoulder room, front, in.	55 1/2	—
Shoulder room, rear, in.	54 1/2	—
Oil capacity, qt	6	—
Coolant capacity, qt†	11	17
Fuel tank, gal	18	—
Brake size, front, in.	10 x 2	11 x 2 1/4
Brake size, rear, in.	9 x 2	10 x 2
Total glass area, sq in.#	3232	—
Usable trunk space, cu ft#	16.5	—

† Add one quart for heater # Four-door sedan

Develop Tiny Flashlight with Recharging Device

VIENNA, AUSTRIA—A 30-gram flashlight that gives continuous light for 1 hr after a 14-hr 220-volt ac charging period, has been developed here.

Previous models had the recharging unit built in with the flashlight case. With the new model, a separate charging unit is plugged between a wall outlet and the "power end" of the dry-cell flashlight battery.

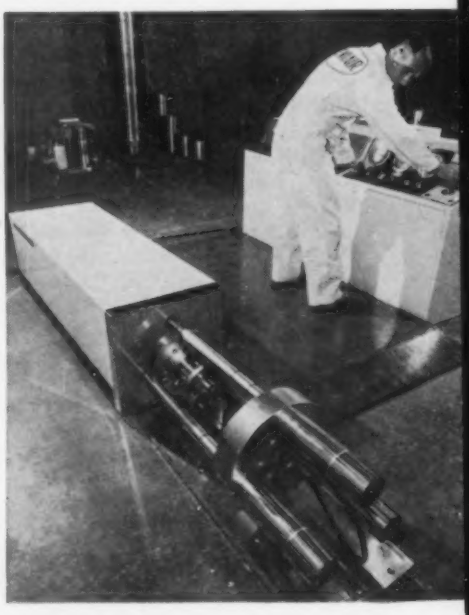
Gas-ram Machine Opens New Fields for Metal Forming

CLEVELAND—A new high-velocity forming machine—400 fps—demonstrated at the Metal Show here by Convair Div of General Dynamics, opens a way to form materials where this was formerly impossible or too costly. Based on a device developed by Convair for shock-testing missile components, this metal-forming tool can generate several million pounds of load on a workpiece. It uses a triggered gas-powered ram to deliver energy in milliseconds to a free-piston column.

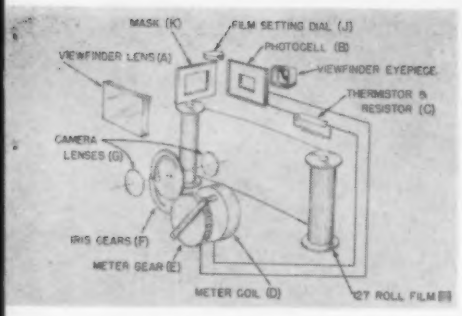
At the resulting high velocities, many metals exhibit hydrodynamic behavior. Parts can be produced with web thickness of only 0.010 in.; forgings can have zero draft angle. Surfaces can be so smooth that no finishing is needed. The operation is precisely delivered. The machine is readily adapted to automatic operation with cycle times of 1 minute or less.

EQUIPMENT IS COMPACT

This high-velocity equipment is remarkably compact. A machine delivering 160,000 ft/lb of energy is only 3 ft wide and high, and 12 ft long. A dynamic reaction frame gives the machine its own shock absorber. Floor loading is unnecessary, as demonstrated with the machine on display. It was set on the convention-hall floor with negligible fastening.



Versatile machine tool . . . the Dynapak, is capable of high energy-rate extrusion, forging, sheet-metal forming, compacting ceramics and other jobs. Here technician prepares to fire gas-energized tool by setting single console dial.



First fully automatic still camera . . .

has been developed for the commercial market by Bell & Howell. A selenium-plate photocell computes the light reading and sets the lens opening. Light entering the large viewfinder (A) at top of camera generates a small electric current within the photocell (B) located at the rear and inside the viewfinder. Current flows through a miniaturized circuit with compensation for temperature variations being made through a resistor and thermistor (C). When current enters meter coil (D), it deflects or turns the meter gear (E) in accordance with the strength of the current which in turn also activates the geared iris (F) or lens opening, automatically adjusting it for the existing light condition. Since iris opening is in constant adjustment to prevailing light, lens system (G) permits only the exact amount of light for correct exposure to strike the film (H). This reaction to light is faster than that of the human eye. To compensate for slow or fast films, a film setting dial (J) is used to position a mask (K) in relation to the photocell. Stop-and-go system in viewfinder glows green when there's enough light for photo-taking—a red flag goes up when light is inadequate.

Magnesium Makers Eye Car Market

DETROIT—New design concepts based on the properties of magnesium may soon be applied in the US and British automotive industries if the magnesium industry succeeds in reducing ingot cost of the metal to make it more competitive with aluminum.

This was the optimistic note struck during the recent 14th annual convention of the Magnesium Association held here. Developments justifying such optimism were described by Dr. C. J. Smithells, managing director of Magnesium Elektron Ltd.

He said the goal of British producers is magnesium costing no more than 20% more than aluminum. Considering relative weight of the two metals and the differential in specific gravity, it would thus be cheaper to produce magnesium. British have developed a new high-temperature wrought alloy containing thorium, an alloy not requiring heat treatment.

Casting alloys—containing fractional rare earths, neodymium, zinc, and silver—were also announced by England's J. Stone & Co. These alloys they said, have good tensile strength, creep resistance to 500 F, and are weldable as well as easily cast.

In the US, advances are being recorded almost as rapidly. Dow Chemical, prior to the convention, had announced significant improvements in processing magnesium. Brooks & Perkins, who along with Calumet-Hecla, own the Alabama Metallurgical Corp, report plans to extract and produce some 7000 tons a year from the vast deposits of dolomitic rock in the Selma, Ala., area. The extraction plant will use the ferrosilicon process which Brooks & Perkins say they've refined.

Finishing of magnesium, both for corrosion resistance and for appearance, has also improved. The HAE process, as well as color anodizing of magnesium, are widely replacing the method of chromating, and then painting.

Report Poland's First Computer

WARSAW—Poland's first computer, said to resemble Britain's Pegasus, can complete 800 arithmetical and logical elementry problems per sec, has 500 electronic tubes and more than 10,000 parts. It took 2 years to develop.

USSR Claims Thought-control Mechanical Hand

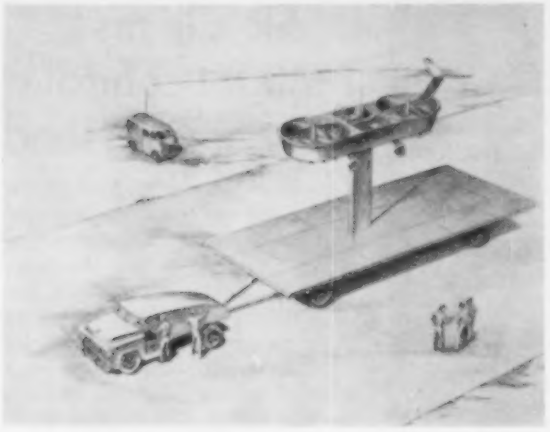
Moscow—The Soviet Medical Research Center asserts it has developed the "Bio-Hand", a device controlled entirely by impulses from the brain.

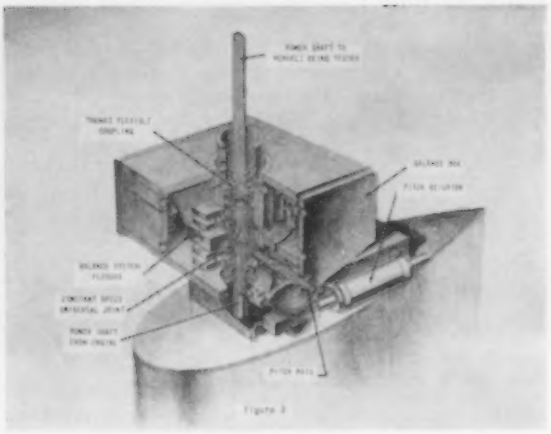
A. J. Kobrinski, leader of the Bio-Hand project, makes the claim that the "mere thought of bunching a fist, for example, is fully sufficient to set a series of minute electrical impulses traveling through the muscles of the hand or arm." In the setup shown here, electrical signals are said to be supplied by a pickup unit attached to the operator's arm and connected to the control cabinet. The mechanical hand is hydraulically operated.

The Soviets say weak bio-electrical currents in polio-weakened muscles can be amplified enough to actuate a replacement for a paralyzed limb. Also, they claim the pulses could be used to treat muscles of paralyzed limbs, or operate artificial breathing machine.

[US sources who claim to have seen the Bio-Hand say it only reproduces muscle movements made up by the operator's hand, and presently is limited to one degree of freedom. The US Air Force and Veteran's Administration are working on similar projects.]

Pickup on operator's arm . . .
relays electrical impulses when he thinks of flexing his fingers to hold the glass.





CAL Building Test Apparatus for Small Rotorcraft, May Replace Costly Wind Tunnels

BUFFALO—Apparatus to test the static and dynamic flying characteristics of small rotor-craft like flying jeeps and platforms is being designed by Cornell Aeronautical Laboratory. Transportation Research and Engineering Command of the Army Transportation Corps, sponsoring the project, hopes it will replace costly full-scale wind tunnel testing.

The setup consists of special touring vehicle, large flatbed trailer with a mast for mounting the test rotorcraft, and a telemetering van to collect data (see above).

This apparatus will be able to test rotor-craft with gross weight up to 3000 lb and rotor dia up to 17 ft. It will provide about 350 hp of external power to craft being tested as well as forward velocities and variable pitch rates. It will isolate the balance system and supporting structure so that road roughness will not affect results; will provide a balance system for measuring aerodynamic loads and 14 channels of telemetered data.

WHAT THEY'LL LEARN

Basic data on the following characteristics of small rotocraft will be obtained: performance in forward autorational and hovering flight; static and dynamic stability.

CAL engineers say the apparatus can be used for testing a tilt-wing vertical take-off airframe for landing and take-off performance.

What Goes in Doesn't Always Come Out, Smog Study Shows

SAN MARINO, CALIF.—Whether or not olefins are present in gasoline before it is pumped into the car tank has no effect on the amount of ozone pollutants in the exhaust coming out the tailpipe, reports the Air Pollution Foundation. Hence, any regulation limiting olefins in gasoline to remove smog would be nonsensical."

"The rapid photochemical reaction of exhaust olefins with nitrogen oxides is what apparently led others to surmise that elimination of olefins from gasoline would somehow eliminate olefins from exhaust, and thereby reduce smog" explains Dr. W. I. Faith, managing director of the independent scientific research foundation.

But the foundation has proved this theory wrong. More important a 12-month study shows that eye-irritation, ozone and visibility-blurring aerosols are produced only when the hydrocarbons in exhaust and the nitric oxide in exhaust are in certain definite proportions to each other. This finding will be a factor in developing an auto mechanism to eliminate smog.

Yugoslavia Installs Reactor

BONN—The first nuclear reactor to be built and operated in Yugoslavia went critical last May 17. The new zero-energy unit is using natural uranium from Russia as fuel and heavy water as moderator.

US to Raise OEEC Ante for More Engineers

PARIS—The US has offered to boost the support it is giving the Organization for European Economic Cooperation in a program to increase the supply of western European scientists and engineers. Washington is raising its donation from $500,000 to $750,000. OEEC countries will have to watch the US grant (*PE—June 16, p 21*).

Now in its first year, the program is headed by Robert L. Clark, formerly Executive Director of the President's Committee on Scientists and Engineers. Plans for the first and second years include:

- Demonstration courses for secondary science and math teachers. Sessions have already been held in England and Germany. France will have one, primarily for math teachers, this month.
- Fellowships for senior scientists to strengthen training institutions and encourage exchange techniques.
- Support of competent institutions in highly specialized fields.
- Study of techniques for training technical personnel in industry.

Aircraft Efficiency Program Studied for Wide Engineering Use

LOS ANGELES—Applicability of the "PACE" program, which, resulted in slashed costs of producing aircraft and missiles at Northrop Aircraft, to various engineering operations is listed as a top-priority project by Richard R. Nolan, vice-president and general manager of the Northrop Division. PACE (Performance And Cost Evaluation) measures group effectiveness in the performance of assigned tasks, and has produced such dramatic improvements, according to Northrop, that the Air Force as well as Boeing, Convair, North American, McDonnell and other manufacturers have sent in engineering teams for briefing on the program.

Northrop developed PACE to give workers in the aircraft industry a standard of effort. In some industries, the moving assembly lines, daily production quotas, or piecework-incentive programs provide such a standard; but in the aircraft and missile industries, the complexity of the end-product is such that hourly or daily progress is not obvious. With workers using different tools to perform a multiplicity of tasks, time-motion studies are ineffective, and the high-reliability requirement favors conscientious work rather than speed alone. Basis of the PACE program is training special observers to determine at a glance how hard a group is working without regard to the individual or collective tasks they are performing. It is this relative unimportance of the individual task that suggests applicability of the method to engineering groups.

TIME STUDY ASPECTS

The PACE idea starts with the assumption that a man walking at the speed of 3 miles per hour is operating at 100% efficiency. Theoretically, he can walk all day at this speed without undue hardship. There is an equivalent speed for any sort of physical activity except where the machine being operated, or some part of the task being performed, has a fixed time cycle that determines the worker's speed at his task. In a repetitive task, the speed of movement equivalent to 3 mph can be determined—just by watching. Once an observer has learned to do this, he can glance at a person—or at all the people in a department—and arrive at a reasonably accurate estimate of their percentage of effort. Other criteria are added which take into consideration the number of people missing from the department at the time the observations are made.

Programs to date have shown many of the PACE criteria are equally valid when applied to some types of office groups, so there is little doubt the method can improve operations of engineering-support organizations and routine engineering.

However, Northrop officials are now trying to learn whether benefits of this method can be extended even to creative engineering. They say they will know more about this in three or four months.

COMING EVENTS

NOVEMBER

12-14 . . . . Society for Experimental Stress Analysis, Annual Meeting, Sheraton-Ten Eyck, Albany, N. Y.

17-21 . . . . Society of the Plastics Industry, Annual National Conference and National Plastics Exposition, International Amphitheater, Morrison Hotel, Chicago.

18-20 . . . . American Standards Association, 9th National Conference on Standards, Hotel Roosevelt, New York.

25 . . . . Manufacturing Chemists Association, 8th Semi-annual Meeting and Winter Conference, Hotel Statler, New York.

28-Dec 4 . . . . Radio Communication & Electronic Engineering Association and Office Appliance & Business Equipment Trades Association, 1st Electronic Computer Exhibition, London, England.

30-Dec 5 . . . . American Association Mechanical Engineers, Annual Meeting, Statler & Sheraton McAlpin Hotels, N. Y.

DECEMBER

1-5 . . . . American Society of Mechanical Engineers, 23rd National Exposition of Power and Mechanical Engineering.

2-4 . . . . Electronic Industries Association, Third Conference on Reliable Electrical Connections, Statler-Hilton Hotel, Dallas, Texas.

30-5 . . . . American Institute of Electrical Engineers, Institute of Radio Engineers Association for Computing Machinery, 1958 Joint Computer Conference, Bellevue-Stratford Hotel, Philadelphia, Penna.

3-5 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, Second National Symposium on Global Communications, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

8-10 . . . . American Nuclear Society Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

RCA Changes Patent Policy; Settles with US

WASHINGTON—Radio Corp of America has agreed to make significant changes in its radio and television patent licensing policies to settle two major, government antitrust suits. No one knows for certain exactly what elimination of RCA's patent pool will mean to the booming electronics manufacturing industry. But Justice Dept antitrust group feel they have succeeded in breaking what they describe as RCA's "strangle hold" on research and invention in the radio-TV field.

The government suits—one criminal and one civil—charged RCA with making it a deliberate policy to monopolize radio-TV research, patents, patent rights, and the issuance and exchange of radio-TV patent licenses. Settlement of these charges cost RCA a $100,000 fine and imposes these terms:

- RCA must license all its existing radio-TV patents—over 10,000 in all—free of charge to the rest of the industry.
- RCA must put its color TV patents —100 specific patents—in a new "pool," to be licensed free of charge to any industry member who joins the pool.
- RCA must license for a reasonable fee all radio-TV patents it receives in the next 10 years.
- RCA must allow its licensee to take some, any, or all the patents they want, thus breaking the so-called "package license" deal.

There are many other provisions, limiting licensing and commercial practices of RCA. For example, RCA's right to receive patent licenses in return for those its grants is sharply limited. Other provisions of the settlement are certain to bring the terms back into court, sooner or later.

One immediate result of the settlement is to wipe out RCA royalty income from existing radio-TV patents. RCA collected over $96-million in royalties from its licenses—largely from its competitors—from 1952 to 1956.

There is some uncertainty over the impact of the antitrust settlement on some recent RCA practices. Last year, largely under the pressure of a private antitrust suit brought by Zenith Radio Corp and the pending government cases, RCA did open up some of its black-and-white television patents on a royalty-free basis to some of its licensees.

Vacuum Pump Freezes Out Air

CAMBRIDGE, MASS.—An unconventional technique for producing extremely high vacuums promises substantial savings for research and industrial uses. It is already being used in missile research. Called Cryopumping, the technique produces so low a temperature that all of the air in a chamber or wind tunnel freezes to a solid, leaving a high vacuum.

Details of the technique were given by Bruce M. Bailey, of Arthur D. Little Inc., research and engineering company of Cambridge, in a paper co-authored with Dr. Raymond L. Chaun, Director of the University of Southern California's Engineering Center. Dr. Chaun developed the first practical, large-scale application of the technique—a hypersonic wind tunnel for testing missile models under high-altitude atmospheric conditions. Bailey and his colleagues at ADL developed the pump. It induces high-speed air flow over the missile models.

BEST WITH MECHANICAL PUMPS

The pump is an extreme-low-temperature refrigerator, using helium gas at minus 420 F as the refrigerant. At present the method is most efficiently used in conjunction with mechanical pumps. Pumping speed of a mechanical system falls off rapidly as vacuum increases, but a cryopump works particularly well when relatively high vacuum exists—so a combined system takes advantage of both methods.

Instead of blowing or pulling air over the test models by conventional means which Bailey says would require pumps and fans filling a huge area, the cryopump freezes out nitrogen gas at one end of the testing chamber, causing a flow of nitrogen from the other end and over the objects being tested. By using nitrogen instead of air, there is no need to remove moisture from the gas stream.

To duplicate high-temperature conditions under which missiles would operate at high speeds, the nitrogen gas is electrically heated when it first enters the tunnel and again just before it flows over the models. It is then drawn onto the large metal plates of the refrigerator, where it condenses and freezes.

The USC tunnel is unique in that its only moving parts are in the refrigerator, powered by a 50-hp motor. A comparable unit based on a gaseous diffusion pump would require 500,000 hp. The tunnel can run 10 hr at a stretch, but most hypersonic test facilities can operate only a fraction of a sec at top speed, altitude .

The tunnel was built on a research contract for the Air Force Office of Scientific Research and the Office of Naval Research.

Featherweight TV Shown by GE

LOUISVILLE, KY.—A completely transistorized, battery-powered TV weighing only 10 lb has been demonstrated by General Electric. Intended for personal use, the portable set is 7¼ in. wide, 7¼ in. deep and 8¾ in. high, and works on both batteries and house current.

Chassis of the tiny TV includes 22 transistors, and a picture tube measuring 8 in. diagonally. Power is supplied by a rechargeable silver-cadmium battery with power consumption of 7½ watts. The battery can be recharged on house current while the set is being used.

Highest Court to Weigh Inventor's Secrecy Plea

WASHINGTON—Inventor Jerome S. Spevack has been granted a Supreme Court hearing in his fight with the Atomic Energy Commission. The case could set important precedents concerning the rights of inventors working in national defense areas.

Spevack claims that AEC plans to publish certain information on heavy water which endangers his rights to obtain foreign patents on a claimed invention. He wants a court order blocking such publication. So far, the federal courts have ruled against Spevack. It is these rulings that the Supreme Court will review.

LOWER COURTS DENY

Spevack's case is complicated because of secrecy imposed to protect his patent rights. But this much is plain—lower courts have rejected his request for an injunction, on the ground that AEC's proposed publication was authorized by the Atomic Energy Act. To date, the courts have ruled that while Spevack may be entitled to bring suit against the Government for any damages caused by publication, he has no right to prevent such publication.

The record shows that AEC action concerns declassification and proposed publication of operating manuals used in AEC installations. These manuals, containing information supplied by Spevack when he was employed as an AEC adviser, explain how a new isotope-concentration process he had invented could be used in heavy-water plants.

AEC agrees Spevack owns the patent rights to his process. But it argues that the subject matter of heavy water is in AEC's domain, and that it is free to declassify and publish such subject matters. Spevack counters that AEC has no authority to disseminate data which it has declassified but which is not owned by the US government.

Off the record, AEC says another such situation "couldn't happen in a 1000 years." But Spevack—and such interested groups as the American Chemical Society and the Engineers Joint Council Inc—will now get the benefit of a Supreme Court ruling on the whole controversy.

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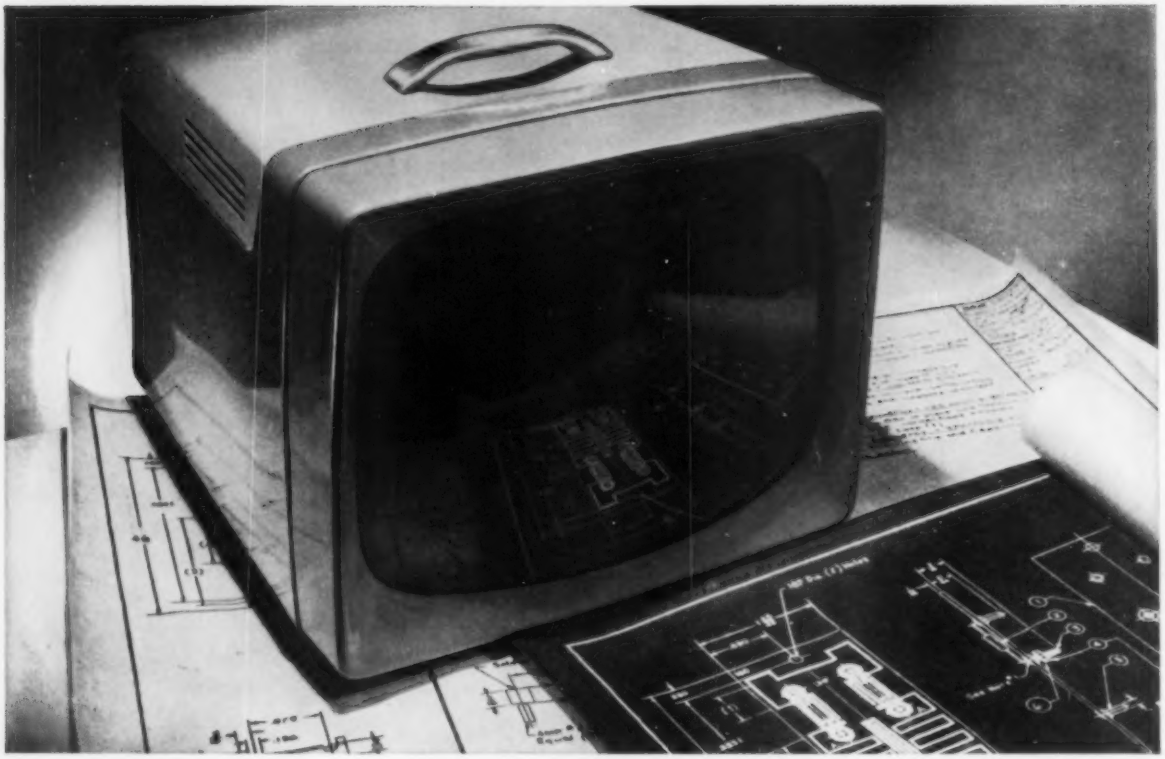


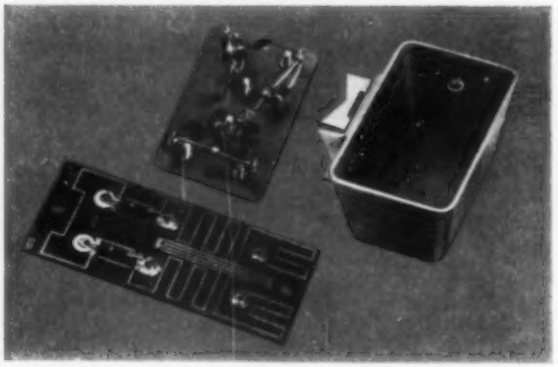
Taylor copper-clad laminate printed circuits reduce cost of TV crossover network by 66%

Also eliminate subsequent installation costs and improve reliability of part

Hugh H. Eby Company, Philadelphia, Pa., has reduced the cost of producing crossover networks for VHF-UHF television sets approximately two-thirds by changing production methods and switching to circuits printed on Taylor copper-clad laminate. It has also eliminated subsequent installation of the part on antenna masts, thereby greatly improving part reliability.

Taylor copper-clad laminate was selected for two reasons: dimensionally stable after hot punching, it assures uniform hole size and good registration; its rolled-copper surface, free of pinholes, pits and lead inclusions, provides consistently good etched circuits.

You, too, may have applications where Taylor copper-clad laminates will cut costs and improve reliability. Our application engineers will be glad to discuss them with you. Both the Norristown, Pa., and La Verne, Calif., plants are equipped for prompt supply of basic materials or fabricated parts. Write us for details. TAYLOR FIBRE CO., Norristown 39, Pa.



Above (right) is shown the old-style crossover network with its housing. Below it is the new printed-circuit network. The small, compact network costs one-third as much to produce and is assembled in the television set instead of on the antenna mast.

Taylor

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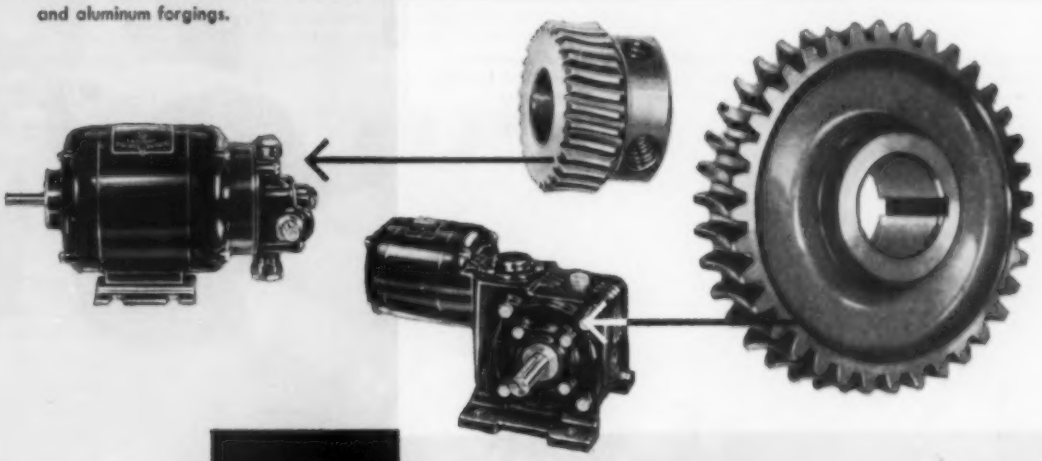
MUELLER BRASS CO. forged gears improve dependability and performance of BODINE electric motors

For combined high shear strength and maximum wear life in their single and double reduction speed reducer motors, Bodine Electric Company of Chicago uses gears forged from Mueller Brass Co. 603 Alloy.

Bodine has specified Mueller Brass Co. forged gear blanks because of their consistently high quality . . . there is no porosity, foreign inclusions or defects typical of cast blanks. The hot working of the metal followed by heat treatment to the desired physical properties produces a refined grain structure to give uniform machining and wear in service. The forged blanks are consistent in size and held to close tolerances. Bodine has also found that the excellent machinability of the blanks in the hobbing operation increases overall hob life.

For forgings of high tensile strength, high density, minimum porosity, light weight, corrosion resistance, good machinability and low costs with little scrap loss, it pays to specify forgings from the Mueller Brass Co., the world's largest producer of brass, bronze and aluminum forgings.



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can offer unbiased advice on the "one best way" of producing your parts, because Mueller Brass Co. is the *only* fabricator in the country offering all these methods of production . . . assuring you the best product at the best price . . . made the one best way.

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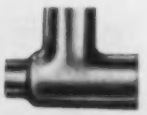

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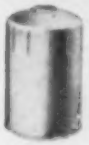

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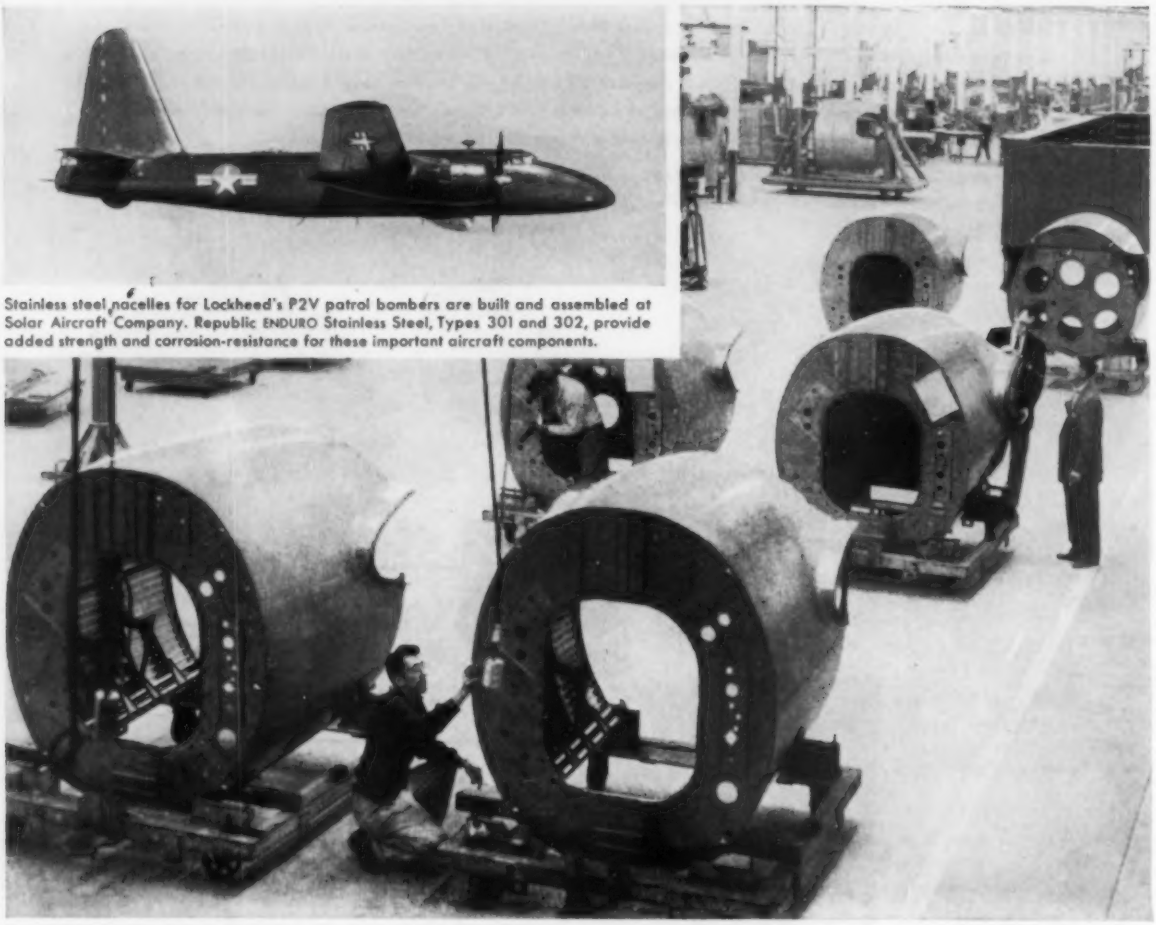


Stainless steel nacelles for Lockheed's P2V patrol bombers are built and assembled at Solar Aircraft Company. Republic ENDURO Stainless Steel, Types 301 and 302, provide added strength and corrosion-resistance for these important aircraft components.

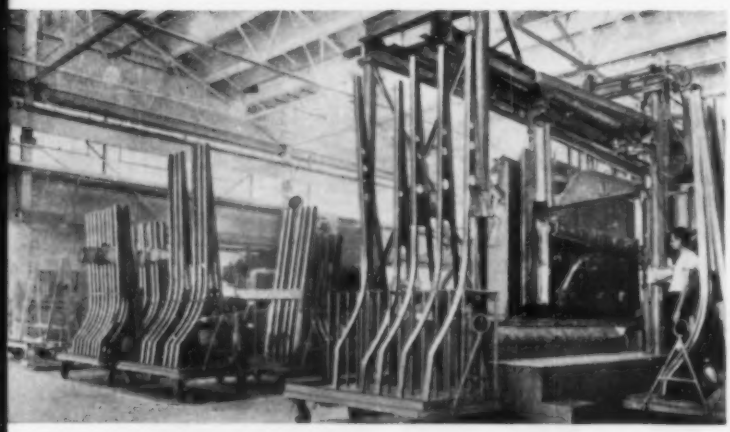
REPUBLIC ENDURO® STAINLESS STEEL HELPS SOLVE strength, heat, and corrosion problems in engine nacelles for the Navy's P2V patrol bombers.

Complete nacelles are built by Solar Aircraft Company, San Diego, California, pioneers in stainless steel airframe construction. To date, Solar has manufactured more than 1000 nacelles for Lockheed's P2V program using A.I.S.I. Types 301 and 302 Stainless Steel.

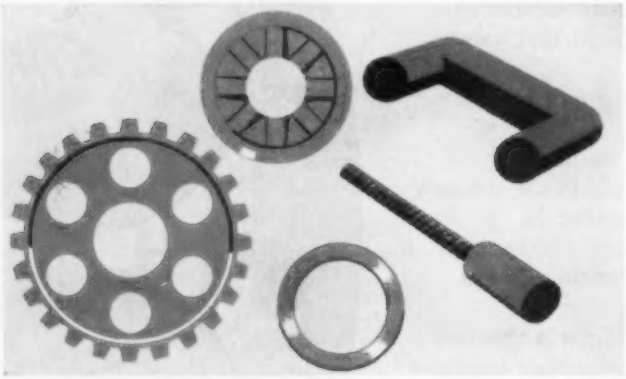
The stainless steel construction of these airframe units offers a number of advantages including greater strength, ability to withstand high temperatures, less maintenance for protection against corrosion and more economical production processes.

Republic ENDURO Stainless Steels, Types 301 and 302, provide needed strength, yet permit the use of lighter gages to save weight. They are highly resistant to atmospheric corrosion, erosion, and oxidation at high temperatures. They are readily formed into desired shapes by the usual commercial methods.

Like Solar, Republic is also a stainless steel pioneer. Republic metallurgists and engineers pioneered the development of these high strength-to-weight, heat-resistant, and corrosion-resistant metals. To help you use them to best advantage, Republic offers you the services of its famed 3-Dimension Metallurgical teams —field, mill, and laboratory metallurgists. The coupon is your invitation to use this confidential and obligation-free service.



ALLOY STEEL WELDMENTS meet high strength, precision requirements in USAF bombers. The weldment technique, developed by Rohr Aircraft Corporation, Chula Vista, California, is currently being used in the manufacture of flap tracks for an Air Force Bomber program. The material used is AMS 6428 Alloy Steel, a type supplied by Republic. This fine steel provides a minimum tensile strength of 180,000 psi in the heat treated condition. Uniform response to heat treatment assures exceptionally good deep hardening characteristics—plus hard-wear-resistant surfaces. Specify Republic Alloy Steel for your parts that must be tough, strong, dependable. Our metallurgists will help you. Send coupon for facts.



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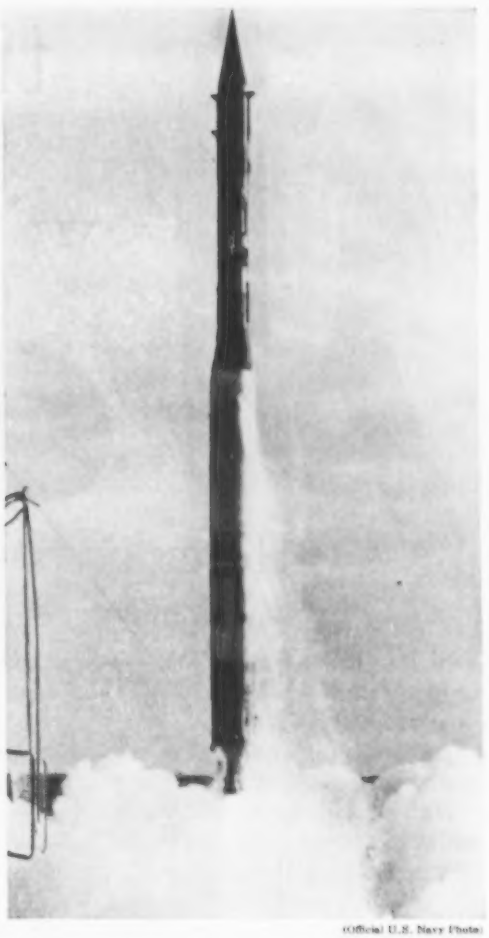

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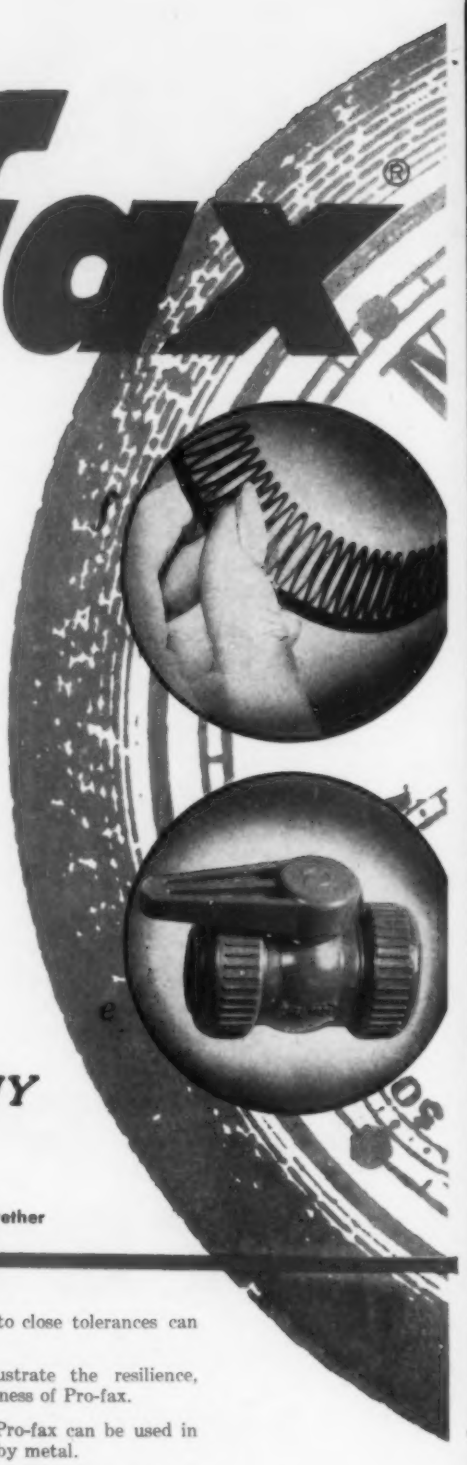

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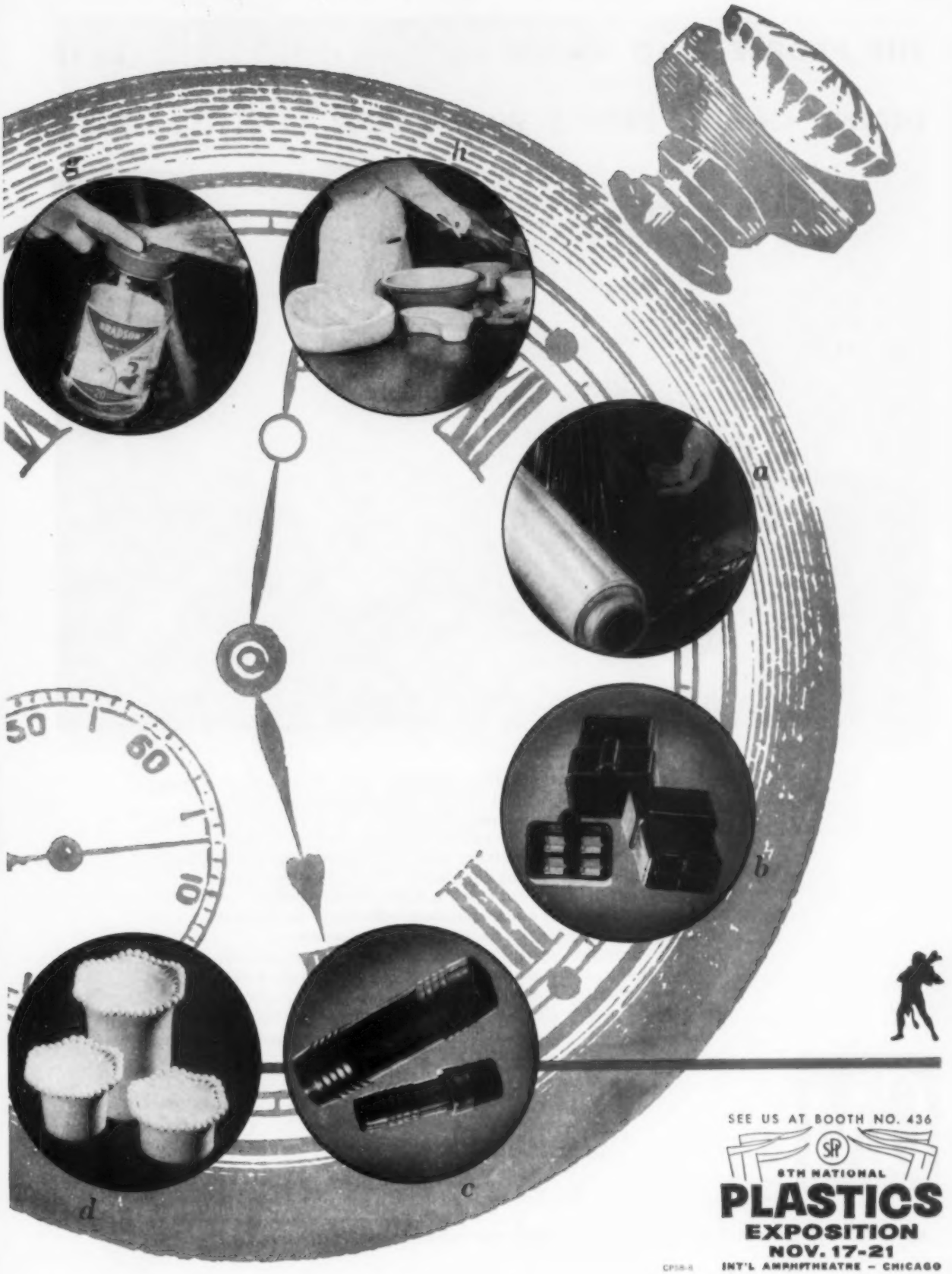

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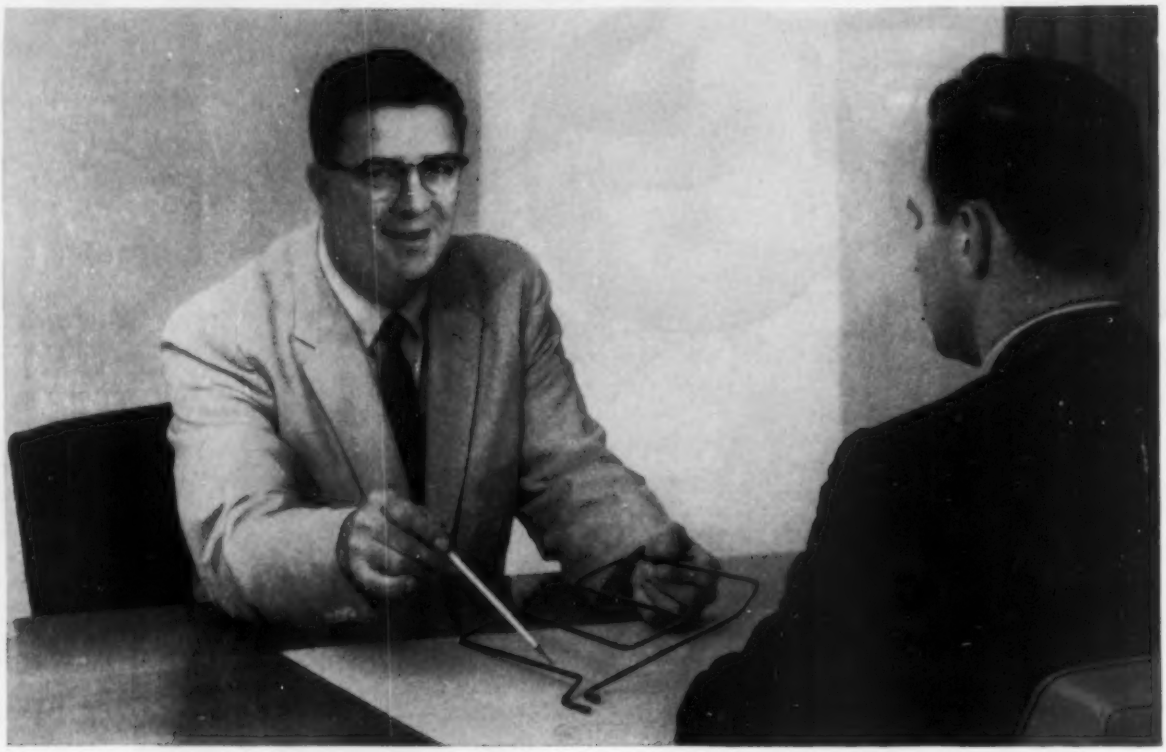

He knows refrigeration tubing problems *cold!* He's Glenn Eastman, one of the many GM Steel Tubing Sales Engineers who work with leading refrigeration manufacturers to help them get the most for their tubing dollar. He can recommend the best and most economical means of satisfying your specifications on existing high production manufacturing equipment. His knowledge of the industry will help you cut costs in tubular refrigeration components and still retain maximum efficiency. And he knows that GM Steel Tubing is the cleanest you can buy, quality-controlled beyond specifications for greater strength and dependability. Put some on test in your plant today. You'll see why GM Steel Tubing leads in refrigeration sales . . . *by miles!*
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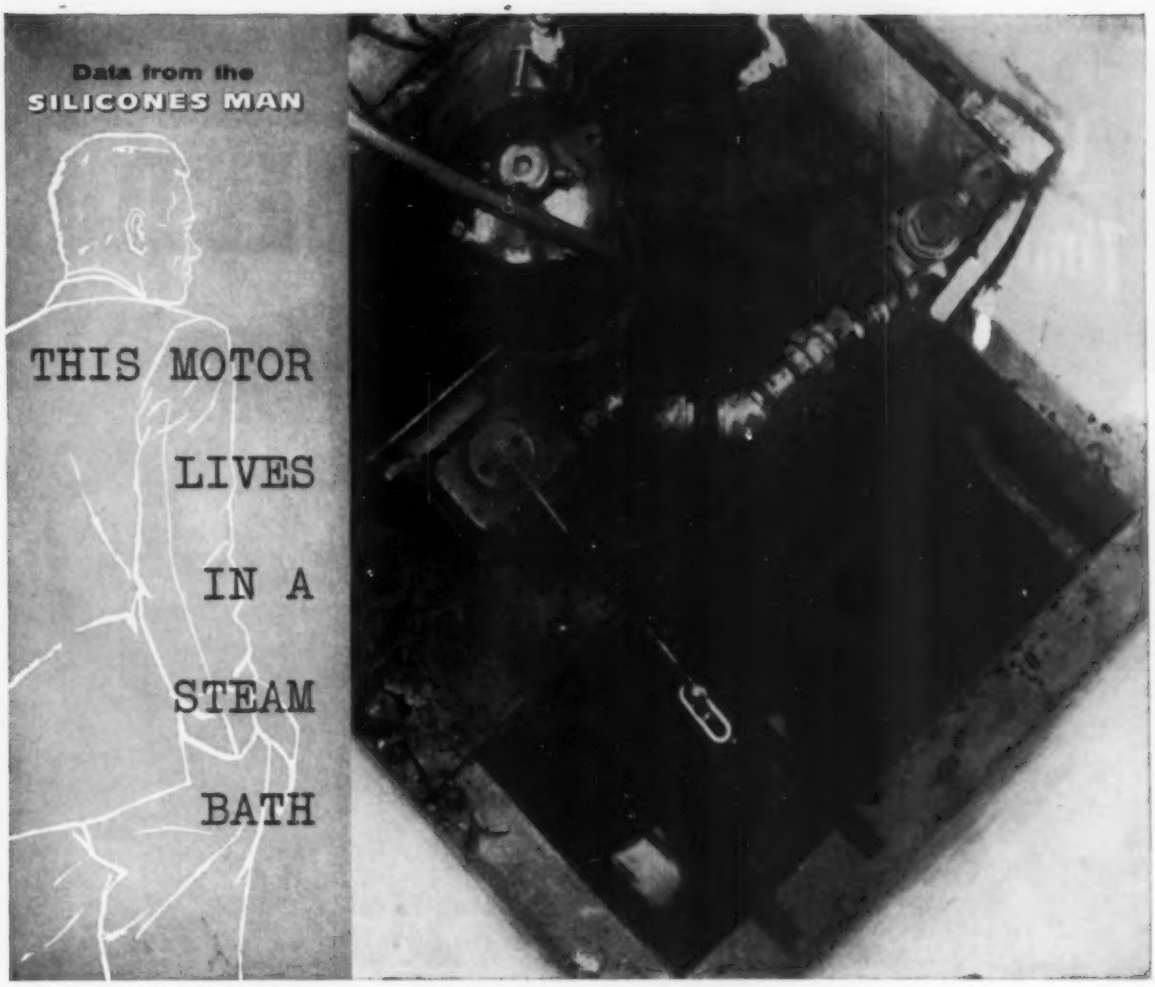

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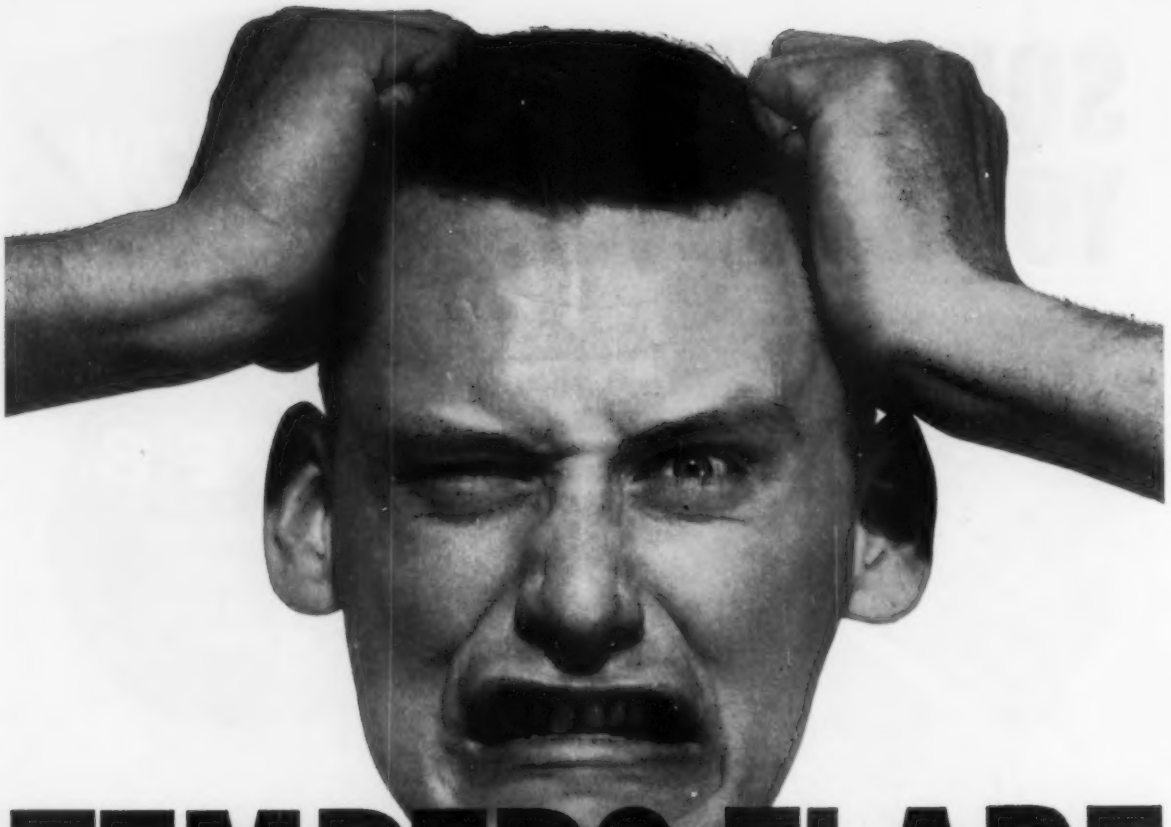
Accuracy	±15%	±10%
Interlocks	None	Max. 2 Double Circuit
Panel Space	2⅛" x 4"	2½" x 7⅛"
Convertible Delay-On • Delay-Off	Yes	Yes
Maximum Voltage, AC-DC	600 V. AC only	600 V. AC • 250 V. DC

Everybody's Ahead with Square D!



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"Take any operation where assemblers must match-up tapped holes, avoid cross-threading, and drive machine screws into place—and you could be sitting on dynamite.

"When strip-outs occur (and they will), work stops or the piece must be removed from the line. The hole must be enlarged, re-tapped, a larger screw used, and you know what this means to employees working under a bonus plan.

"Or take the case of our *Portagraph* units," says MR. E. G. LAYER, ENGINEERING SUPERVISOR AT REMINGTON RAND SYSTEMS DIVISION IN TONAWANDA, N. Y. "Here, where plastic sockets are mounted, assemblers had to hold nuts in place under a steel sheet while screws were driven down from above. Get on the receiving end of bitter complaints about cut and bruised fingers, and you start looking for a better solution in a hurry."

The solution to both problems was simple. When Remington Rand switched to PARKER-KALON SELF-TAPPING SCREWS, these labor grievances quickly disappeared. If you'd like advice on proper types of fasteners for your product, a Parker-Kalon Field Engineer will be glad to be of assistance.

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the cylinder you designed!

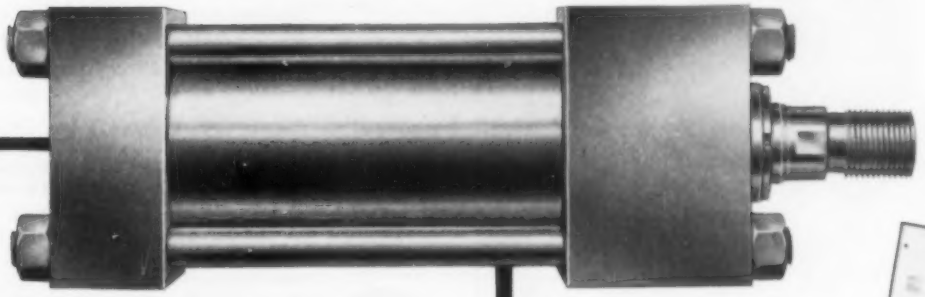
To save you and hundreds of other busy engineers time at the drawing board, Hanna representatives asked what you desired in hydraulic cylinder design.

You wanted a **stronger cylinder, preferably all steel with welded mountings.** You also wanted **tight sealing** at all pressures. These features were included in the Hanna Powrdraulic design. Some wanted **automotive piston rings;** others wanted **synthetic piston packings,** so the new flexible Powrdraulic design gives you a choice. You can also choose the **fast change cartridge gland** or the conventional **multiple lip packing** and you have a **choice of packing material** including Teflon* and silicone rubber.

Hydraulic cylinders should incorporate **industry standard mounting dimensions** and conform to Joint Industry Conference recommendations. These are included in the Powrdraulic design.

In addition, you want a cylinder that is **priced right,** with **prompt delivery** and **service available** in all parts of the country. You can have all this plus the assurance of quality when you specify Hanna Powrdraulic cylinders.

We will be happy to send you a catalog, and give you the name of your nearest Hanna Representative. You'll also find him listed in the yellow pages under "Cylinders" and in the alphabetical section of Thomas' Register.



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Featuring — Pressure tightening tube seals
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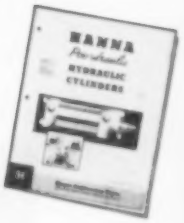

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* Teflon is DuPont's registered trademark for its fluorocarbon resins.

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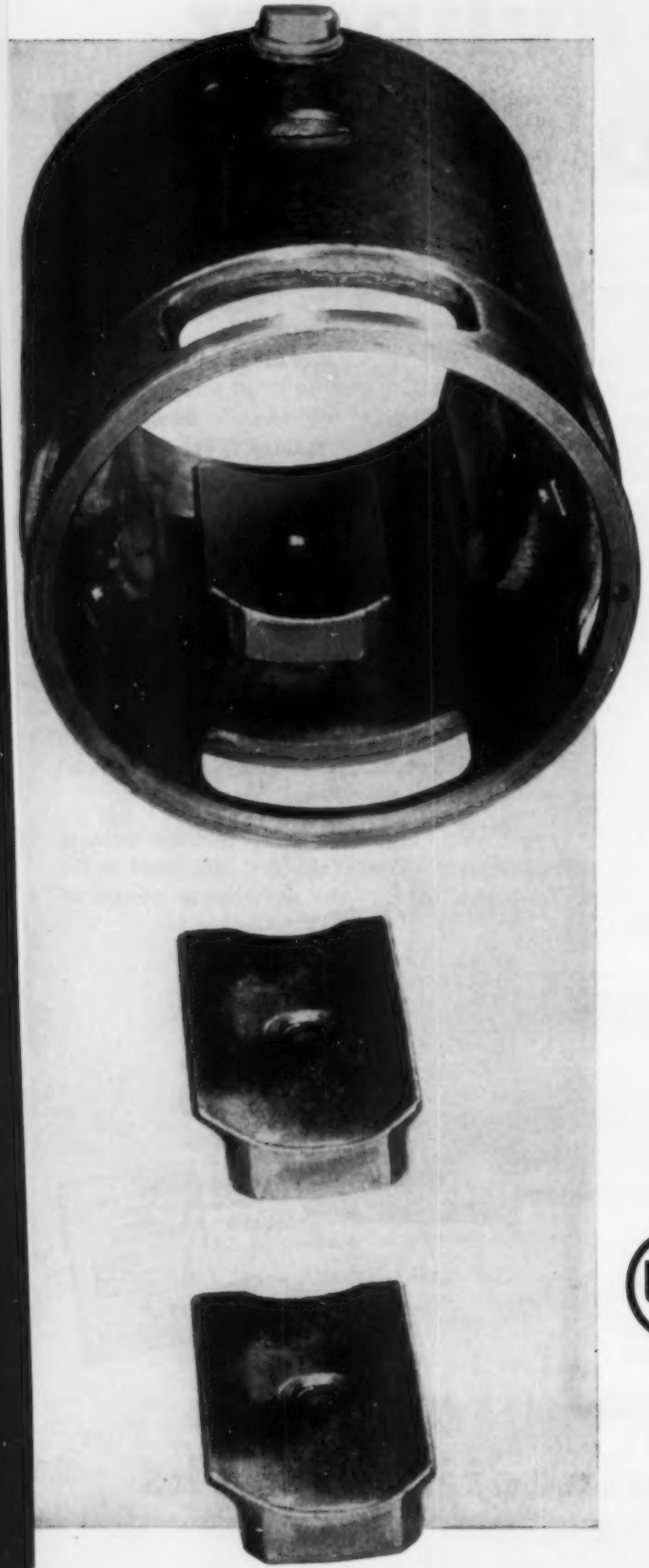

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made from steel already rolled to shape!

An automobile parts manufacturer produces thousands of automobile starter motors daily. Each one takes four pole shoes. To machine these parts from rectangular bars or to use built-up laminations was too slow and too costly.

They solved the problem by making the pole shoe from USS Special Section Rolled Steel Bars. The cross section of the bar is rolled so close to that of the pole shoe that no machining is required. They merely shear the shoe to length, punch the mounting hole, clean and tumble, coin to obtain precise curvature, and tap the hole.

These operations are set up on a mass-production basis and pole shoes come tumbling out at a rate of 11,000 per day, or more. There's very little scrap and unit costs have been reduced to a minimum.

Why not find out what USS Special Sections can do for you? For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS is a registered trademark

A better product at lower cost when pole shoes are manufactured from USS Special Section Bars.

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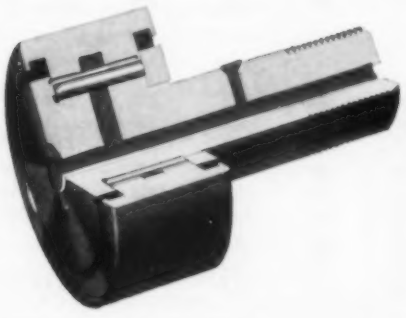

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DESIGNING WITH ALUMINUM

NO. 29

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

DESIGNING WITH ALUMINUM SCREW MACHINE PRODUCTS

RECENT INNOVATIONS in screw machine equipment have made possible great strides in the accuracy, versatility and output rates of both single and multiple spindle machines. These advancements, such as spindle-stopping attachments, increased spindle speeds and numerous secondary-operation accessories, along with the superior working qualities of improved aluminum alloys, have created new opportunities for the designer of precision, high-volume production parts.

Advantages of the Screw Machine Process

The screw machine process serves two primary design considerations: high quality and low production cost. Thus, whenever design of the parts permits, screw machining is usually chosen in preference to other fabricating methods.

High quality of product is, in part, the result of high quality starting materials. The rod, bar and wire used in screw machine work is wrought during the forming process, thus acquiring good density, low porosity and fine grain structure. These properties are conducive to excellent machinability, faithful detail and fine surface finish.

Materials having these properties, when worked in a process of inherently high accuracy and close control, produce parts of dependable dimensions and great uniformity. Accurate concentricity and mating-part fits are attained, with closer tolerances possible than in any other primary fabricating method. For example, Class 3 threads, and other features of similar fineness, may be turned without undue difficulty.

The properties contributing to high quality also contribute to low production cost. Fewer secondary operations are necessary, because of the fine as-machined surface finishes, the intricacy of detail and the dimensional accuracy possible in the basic screw machine process. Rejection rates are low, and subsequent automatic handling processes are facilitated by the uniformity of the parts.

Reduced unit costs also stem from the wide range of available high speed equipment and mill-standard raw materials, the relative simplicity of machining set-up and the faster delivery of finished parts. Expensive dies and fixtures are not required. And because stock cutting tools generally may be used, tooling and maintenance costs are minimized. In-process modification of parts is relatively quick and easy.

Added Advantages with Aluminum

The designer will find these native features of the screw machine process even more valuable when the physical and mechanical advantages of aluminum are considered.

Fig. 1

TYPICAL PROPERTIES OF ALUMINUM SCREW MACHINE ALLOYS COMPARED WITH STEEL AND FREE-CUTTING BRASS

	Tensile Strength (psi)	Yield Strength (psi)	Shear Strength (psi)	Elongation (% in 2 in.)	Hardness (Brinell)	Modulus of Elasticity (psi)	Density (lb./cu. in.)	Electrical* Resistivity	Thermal† Conductivity	Thermal Expansion (68 to 580 F.)
B1113 Steel (Cold Drawn)	85,000	75,000	—	14	170	29.0×10^6	.283	20.0	360	12.8×10^6
C1018 Steel (Cold Drawn)	82,000	70,000	—	20	163	"	"	"	"	"
B1112 Steel (Cold Drawn)	82,500	71,000	—	15	170	30.0×10^6	"	"	"	"
#271 Brass (Free Cutting)	58,000	45,000	34,000	25	143	14.0×10^6	.307	6.6	800	20.5×10^6
ALUMINUM ALLOYS										
2011-T3	55,000	43,000	32,000	15	95	10.2×10^6	.102	4.8	990	22.9×10^6
2011-T8	59,000	45,000	35,000	12	100	10.3×10^6	.102	4.8	990	
2014-T4	62,000	42,000	38,000	20	105	10.6×10^6	.101	5.7	840	23.3×10^6
2017-T4	62,000	40,000	38,000	22	105	10.5×10^6	.101	5.7	840	23.5×10^6
2024-T4	68,000	47,000	41,000	19	120	10.6×10^6	.100	5.7	840	23.2×10^6
6061-0	18,000	8,000	12,000	30	30	10.0×10^6	.098	3.8	1190	23.5×10^6
6061-T4	33,000	21,000	24,000	25	65	10.0×10^6	.098	4.3	1170	
6061-T6	45,000	40,000	30,000	17	95	10.0×10^6	.098	4.3	1170	
7075-T6	83,000	73,000	48,000	11	150	10.4×10^6	.101	5.7	840	23.6×10^6

*In microhms/cm. at 68 F. †In B.T.U. per inch per square foot per hour.

While almost all aluminum alloys are well adapted to machining, a number of them are especially designed for turn-cutting operations. The wide range of these alloys permits matching the characteristics of the alloy to the working requirements of the part. Some aluminum alloys provide strength properties approaching those of cold-drawn mild steel. Others have machining qualities equal to free-cutting brass. All have good corrosion resistance under proper conditions of use.

Alloy 2011, for example, the most popular aluminum alloy for screw machined products, is an especially free-machining metal with excellent mechanical properties, accepting heavy feeds at high cutting speeds. This alloy, and some of the other aluminum alloys available for the designer's selection of optimum property combinations, is listed in Fig. 1 along with representative brass and steel materials.

Alloy 2017, which like 2011 is one of the most frequently selected aluminum alloys for screw machine work, has somewhat higher ductility than 2011, while retaining good machining qualities.

Strongest of these copper-bearing aluminum alloys is 2024, which can be readily roll-threaded, spot welded and finished to fine surface qualities. It is widely used for durable fittings and fasteners.

The 6061 and 7075 alloys listed in Fig. 1 illustrate the versatility of aluminum for screw machine product applications. Note that 6061, for example, increases five-fold in yield strength from its annealed condition to its T6 temper stage, which is attained simply by heat treating. This 6061 material is readily welded by all methods, may be torch or furnace brazed, and has good resistance to corrosive attack as well as excellent machinability.

Alloy 7075 offers the strength qualities of cold-drawn steel *at one-third of the weight per volume* in an easily machined, spot weldable material.

More Helpful Design Properties

In addition to their qualities of superior machinability and high strength-to-weight ratio, these aluminum alloys offer many other properties helpful to the screw machine product designer.

For electrical usages, aluminum alloys offer conductivity, in proportion to weight, ranging up to double that of electrolytic copper. Similarly, thermal conductivity is higher than in free-cutting brass and three or four times greater than in ferrous metals. This quality affords quick, even distribution of heat, where heat is desired, while providing rapid dispersion of undesirable heat. Thus, aluminum terminals, fittings and other parts designed for screw machine fabrication are of great value in electrical equipment, appliances and other high-volume production items.

Another unique property of aluminum, valuable to many modern designers, is its retention of structural strength at low temperature levels. Aluminum alloys actually increase in tensile strength and elongation, without embrittlement, as temperatures drop. The increasing demand for precision fittings and accessories in liquid-gas fueled missiles, for example, gives great significance to this unusual feature of aluminum for screw machine parts.

Still another valuable design property of aluminum is superior resilience under stress, especially in the stronger alloys, due to low modulus of elasticity. In a component subject to normal operating loadings, not involving excessive impulsive shocks or fatigue effects, the ability, "U," of a metal to absorb energy from tensile or compressive strains may be expressed as:

$$U = V\frac{S^2}{2E}$$

where stress S, in psi, does not exceed yield strength; V is the volume of metal under this stress; E is elastic modulus.

The relative capacity of aluminum to absorb energy may then be observed, for equal volumes and equal elastic strengths, as the simple ratios:

$$\frac{\text{U aluminum}}{\text{U brass}} = 1.36, \text{ and } \frac{\text{U aluminum}}{\text{U steel}} = 2.91$$

For equal elastic strengths and equal weights:

$$\frac{\text{U aluminum}}{\text{U brass}} = 4.1, \text{ and } \frac{\text{U aluminum}}{\text{U steel}} = 8.1$$

(Equations derived from values in table below—taken from ASM Metals Handbook.)

Metal	E (psi)	Density lbs./cu. in.
Aluminum (2011)	10.3×10^6	.102
Free Cutting Brass	14×10^6	.307
Steel (B1112)	30×10^6	.283

Variety of Finishes Applicable

Among further advantages of aluminum screw machine products is the great variety of mechanical, chemical and electro-chemical finishes applicable to these alloys. While aluminum screw machining alloys have attractive natural appearance, artificially induced finishes may be preferred or required for many applications.

Decorative effects may be obtained by permanent color anodizing or by applied coatings. Other finishes are used to reduce non-lubricated friction between moving surfaces in contact, to improve resistance against abrasion and corrosion, to provide better adherence of paints or adhesive materials, and for many other reasons. Some of these available finishing processes are described in Fig. 2 on following page.

Some means of corrosion protection may be required when aluminum screw machine products are used in contact with dissimilar metals in a corrosive environment. Various means may be used to provide this protection.

Aluminum Offers Cost Advantages

Further help in solving the designer's problems in production economy is offered by the behavior of aluminum in shop handling and machining. The mill-standard starting materials are available, in broad size ranges, from distributor stocks throughout the country. Providing three times as much volume per pound as heavier common commercial metals, aluminum use reduces freight and shop handling costs for both raw materials and finished products. Natural corrosion resistance reduces or eliminates need for special protective attention under storage.

In the machining process, aluminum materials offer more rapid dissipation of heat, long tool life and greater stability of as-machined finish. The lightweight, finely-divided chips are easy to remove from production parts and machinery. Thus, the advantages of designing with aluminum alloys are found in all phases of cost, convenience, fabrication and function.

What the Designer Conceives... Aluminum Achieves

To help designers make full use of up-to-date developments, the following

Fig. 2

SOME AVAILABLE FINISHES FOR ALUMINUM SCREW MACHINE PRODUCTS

Type of Finish	Name of Finish	Principle Purpose of Finish
Mechanical	Grinding	To remove surface imperfections.
	Polishing, buffing and coloring	To remove surface imperfections and to achieve decorative finish.
	Scratch brushing	To obtain a coarse- or smooth-lined texture.
	Satin finish	To obtain a soft, smooth sheen.
	Burnishing	To impart fine finish to a large number of small parts.
	Sand blasting	To produce a uniform matte surface.
Chemical	Caustic Etch	Decorative "frosted" finish.
	Crystalline chromate	Paint base.
	Chromate-phosphate-fluoride	Paint base.
	Phosphoric acid	Paint base.
	Chemical polishing	Bright finish or base for anodizing.
	Zincate	Base for electroplating.
Electrolytic Oxide	Sulfuric acid anodize	Hard, corrosion-resistant oxide film, base for dyed coatings.
	Chromic acid anodize	Hard, corrosion-resistant oxide film.
	*Hard anodizing	Extremely hard, corrosion- and wear-resistant film.
	Electrolytic polish	High light reflectivity.
Electroplating	Chromium plate	Abrasion-resistant and decorative.
	Copper plate	To promote solderability, decrease electrical surface-resistance.
	Silver plate	Decrease surface resistance.
Painting	Paint, lacquer, enamel	Decorative, corrosion resistant.
	*Porcelain enamel	Hard, decorative, corrosion-resistant coatings.

*For use only with 6061 aluminum alloy.

checklists summarize the advantages of modern screw machine production and the advantages of aluminum:

12 Advantages of Screw Machine Production

1. Starting material is a wrought product which gives high properties in the finished part.
2. Very fine threads possible—as well as accurate threading.
3. Excellent finishing possibilities—anodizing, etching, buffing, etc. As-machined finish gives very fine surface.
4. Closer tolerances and more intricate parts possible than with other methods. Mating parts match better.
5. Excellent concentricity is guaranteed.
6. Fewer rejects for porosity when compared to a cast part.
7. Lower costs for production tooling, dies, set-up; faster delivery of finished parts possible due to fast availability of tooling, speed of set-up.
8. Modification of parts in production easier and less costly.
9. Wide range of equipment and facilities available throughout the country.
10. Fewer secondary operations necessary; possible to avoid secondary finishing by using the as-machined surface.
11. Lower costs for actual production due to high rates of production with available new equipment.
12. Lower costs for finished parts due to competitive pricing among large number of suppliers.

12 Advantages of Aluminum

1. Light weight—moving parts present less resistance to applied force, wear less; chips float out of recesses better for cleaning finished parts. Easier handling of raw material in plant, lower freight costs on finished parts.
2. Non-magnetic.
3. Corrosion resistant—can often eliminate finishing.
4. Non-sparking.
5. Lower raw material cost per part.
6. Greater conductivity—helps dissipate machining heat.
7. Some alloys less susceptible to radiation absorption.
8. More alloys available than some other metals, allowing a particular alloy to be related to a particular part.
9. Less price fluctuation on raw materials.
10. Stock readily available. Size range broad and well stocked at distributors throughout the country.
11. New procedures in producing aluminum screw machine stock now give greater tool life and higher production. New processes such as Electrofilming and Kanigen Coating have overcome old problems as galling and binding.
12. Technical literature for designing purposes readily available.

Engineering advisory services and technical literature on conversions to aluminum in screw machining are available without obligation to interested manufacturers. For further information and professional design assistance, inquire through the Kaiser Aluminum sales office listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois. *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

see our catalog in PRODUCT DESIGN FILE or write for copy

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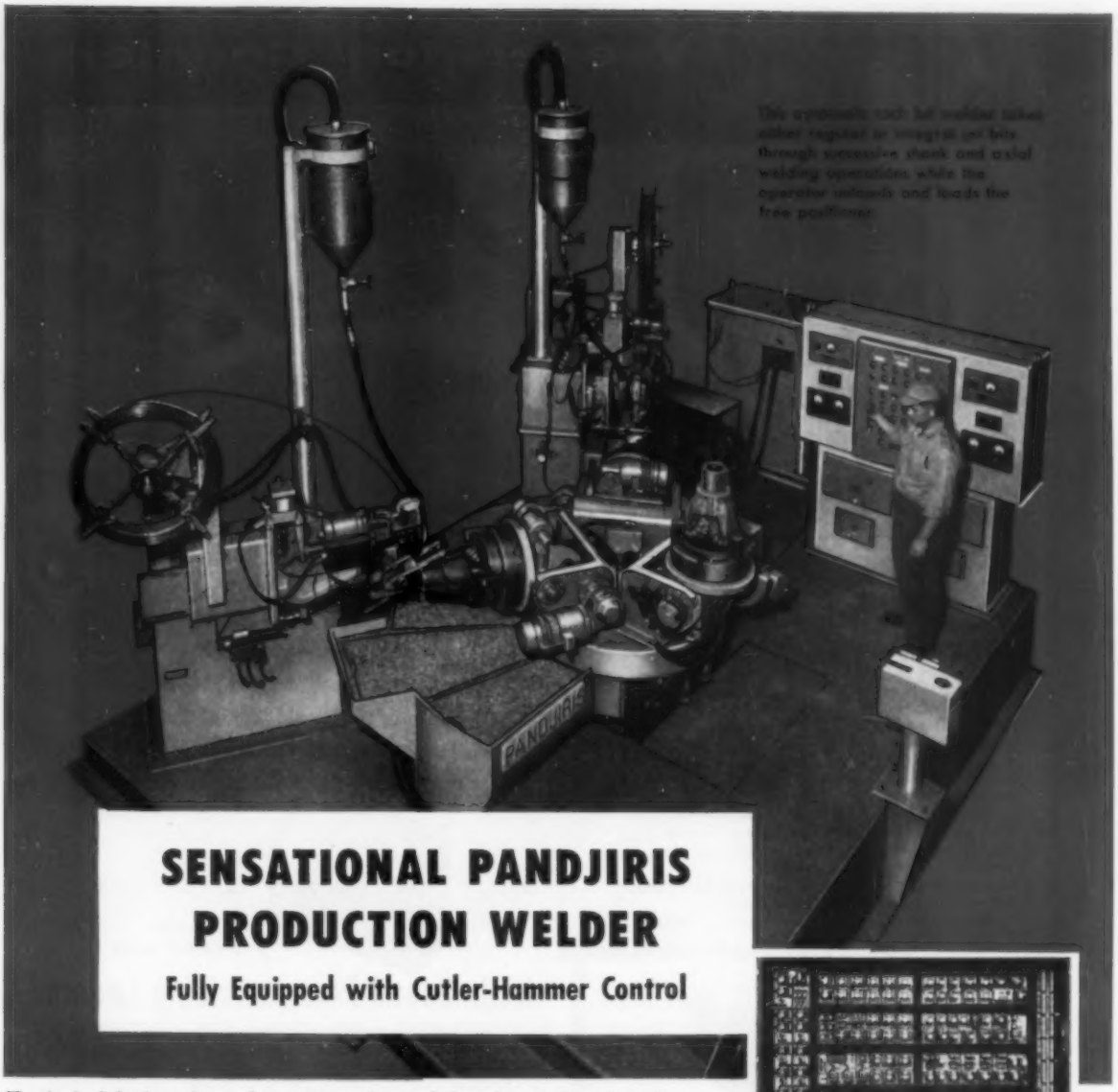
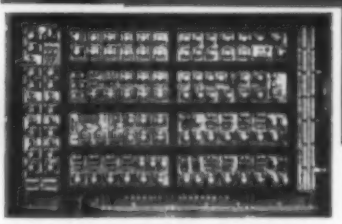


SENSATIONAL PANDJIRIS PRODUCTION WELDER

Fully Equipped with Cutler-Hammer Control



The electrical control cubicle contains all the Cutler-Hammer Three-Star Control components which control each machine motion.

Typical of the broad trend to automation and the advanced engineering which makes it possible is the new Pandjiris AUTO-WELD-MATON* transfer type production welder for the manufacture of rock bits. Typical of automation projects, its very heart is a complex system of electrical control equipment. And typical of the best in engineering, this control equipment is 100% Cutler-Hammer.

The Pandjiris Weldment Co., St. Louis, Missouri, has long been a leader in the design and manufacture of production welding equipment, positioners, turning rolls, weld-evators, head manipulators, etc., as well as the spectacular Pandjiris AUTO-WELD-MATONS custom engineered to specific mass production requirements. Dependable performance built the Pandjiris reputation and Cutler-Hammer is proud that Cutler-Hammer Three-Star Motor Control and Cutler-Hammer Heavy Duty Oil Tight Pushbuttons are furnished as standard original equipment on all Pandjiris machines. For prompt attention to your control requirements write Dept. W249, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

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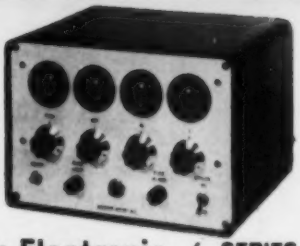

New Electronic Predetermining Counters

SERIES 1604

These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slittling, stacking and material handling.

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This is your complete package for predetermining counting at high speeds.

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Complete electronic counting package for use where high speed, long life and instant reset are required. Highly suitable for high speed direct counting applications such as can and bottle counting or case or piece counting on conveyor lines.

Consists of glow-transfer cold-cathode counting tube and high speed magnetic counter, coupled with transistorized circuits. Photohead designed to your application.

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Write for complete specifications and prices today!

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Ideal for high-speed counting requirements such as coil winding, textile spinning frames, and other predetermining counter requirements.

Instant quick-lever reset, plus quick and easy setting of the predetermined number are outstanding features of this counter. Measures approximately 2.6" wide, 5" long, 2.8" high. Speeds up to 6,000 RPM or 8,000 CPM are maximums recommended.

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Also available as a high-speed revolution counter without predetermining feature.

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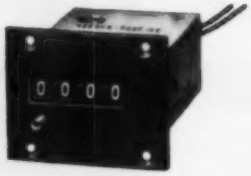

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Panel Area: 4-figure Counter — 1.7" x 2.1"
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Available for 6, 12, 24, 48 and 115 volts D.C. operation. For A.C. operation suitable electrical components must be added externally. Reset voltages available are 6, 12, 24, 48, 115 and 230.

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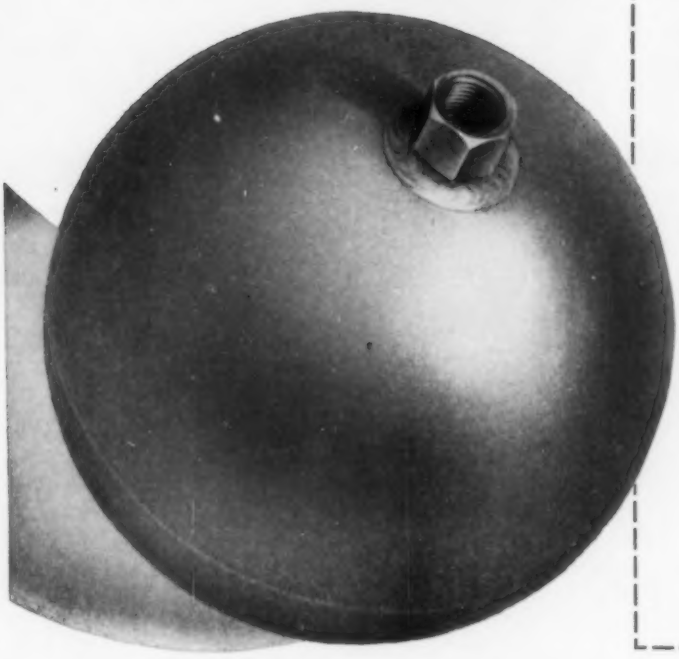

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Solution: The Century Electric sales engineer studied the motor drive for the unit. He proposed a new gearmotor drive to replace the cumbersome mechanical transmission system. The compact Century Electric gearmotor required less space and was easier to install and maintain. Fewer parts were required—assembly was simplified. Savings in manufacturing costs: $192. The manufacturer was well on his way to solving his cost problem.

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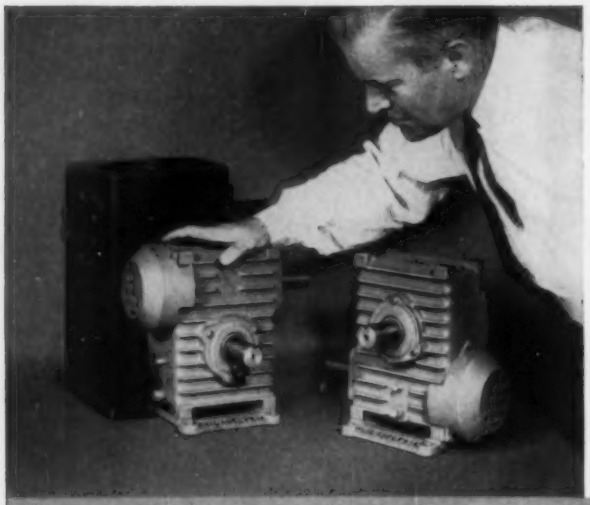

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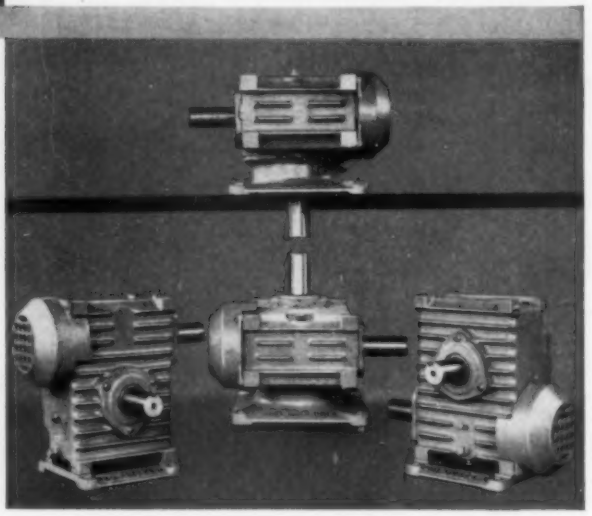

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PERSPECTIVES

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Atomic Energy and the Law (Part 2)

How to get insurance on reactor facilities and how to dispose of radioactive waste products are just two of the legal headaches that face any company working with nuclear materials (*PE—Oct 27, p 41*). David Shea Teeple, an atomic energy consultant to industry and government, goes on to list other problems still awaiting solution. For example:

Transportation of nuclear materials—over roads, waterways, railroads and airlanes. Teeple claims we have no accepted standards with which to evaluate the hazards involved: "We are operating basically under standards issued in 1948 and revised with little change in 1956 by the Bureau of Explosives of the Interstate Commerce Commission. Under these standards, any transported radioactive materials are classified as 'poison' and handled as such. Also the Transportation of Explosives Act applies only to common carriers, making them liable to maximum fines of $10,000 or 10 years' imprisonment, whereas private or contract carriers are prosecuted under Sec. 222 of the Interstate Commerce Act and face a $100 fine.

Teeple also asks: "What about rates? If the goods weigh only 1 lb and the container 20,000 lb, on which item will present state and Federal taxes be levied—weight of the product, or combined weight of the product and container? What portion of the liability is incurred by the shipper and by the carrier? Should Federal insurance extend to carriers? What degree of financial responsibility must the carrier demand from the shipper? Is it worthwhile to incur a potential claim of millions of dollars to make a profit of hundreds of dollars? And, while it might be considered as completely implausible, what is the possibility of accidental criticality caused by two different shipments of fissionable materials arriving at the same location simultaneously?"

And What About Patents?

"The 1954 Atomic Energy Act," according to Teeple, "has the *intention* of making it possible for private capital to invest in nuclear facilities. But under Sec. 152, all atomic energy inventions which are 'made or conceived under any contract, subcontract, or other relationship with the Commission, regardless of whether the arrangement involved expenditure of funds by the Commission, belong to the Government.' The Commission can waive its claim to an invention, but who knows 'when' an inventor 'conceived' an invention, or how to define 'other relationship,' or whether the inventor—subcontractor or prime contractor—has unwittingly gotten into 'an arrangement or other relationship' with the Commission? As more classified patents are released, patent lawyers may anticipate a rash of patent infringement suits, both domestic and foreign."

Still other fields involving atomic energy where the surface has only been scratched are: labor laws—the rights of workers and the matter of workmen's compensation; regulation and control of radiation other than that normally associated with the atomic energy program; and, of course, the legal aspects of a Civil Defense program.

And Teeple adds this reminder; "Perhaps in no other field of human endeavor has so much been published which is not true. Since the first atomic bomb blast, atomic hucksters have over-sold the public to such an extent that the calm education of the people and the orderly examination of the benefits and hazards of this new phenomena have been exceedingly difficult."

—PAUL ANDERSON

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Product Engineering **HORIZONS**

November 10, 1958

Figures don't lie . . .

Or do they?

If you wish to average 30 mph in driving two miles, and make only a 15-mph average the first mile, how fast must you drive the second? The layman promptly says "45 mph"—and is wrong. He's averaging *rates*, but the problem here is *time*, so no matter how fast you drive the second mile, it's hopeless. Your *time* is already used up.

Now turn the problem around and assume you average 45 mph the first mile. What's the required average for the second? Not 15, but 22½ mph.

Every young editor sooner or later allows a respectable engineer to write that he cuts costs 100%, or reduced time 200%. Increases of that magnitude are possible, but reductions like these suggest the discovery of perpetual motion or the fountain of youth. Thus percentages trip us—and give quite false pictures.

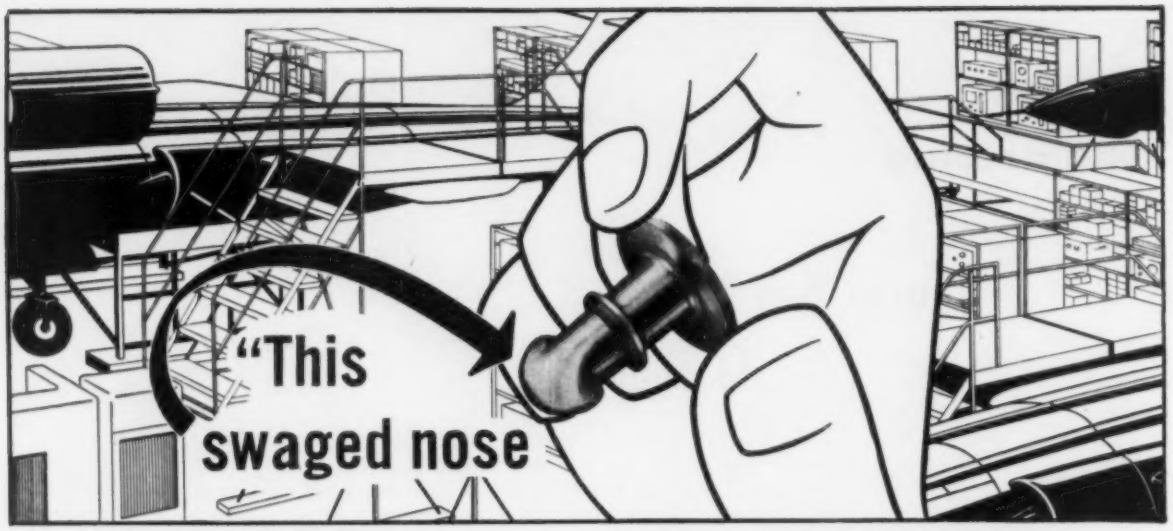
A 100% improvement on a large base is important, but on a small one may be insignificant. The speedometer and odometer on my car read only 10% high, but this means that an hour's driving at 60 mph on a super-highway nets me only 54.5 miles, and when the speedometer reads 60 mph, I'm still within a 55-mph speed limit. This may be considered a safety factor by the manufacturer, but it also means that gas and tire mileages are decidedly less than I might think I'm getting. The same magnitude of error in industrial test results might well be disastrous.

Mere numbers alone are never enough. Nor are charts, curves, statistics. These "facts" are subject to interpretation, which had better be intelligent.

The Soviet Union beats us in ICBM's, Sputnik weights. This is interpreted to mean we are beaten in all things political and military. The divorce rate rises, so someone says that "if the present rate of divorce continues to increase, there will soon be more divorces than there are marriages." Machining at various low speeds provides a characteristic curve of relationship between speed and tool wear; the higher the speed, the shorter the tool life. This is extrapolated on the assumption that the curve will continue its rise. Now tests at much higher speeds indicate the curve not only levels out, but that it may actually turn down.

My college-physics prof was hipped on derivations. "Never use a formula unless you know how it was derived—and be ready to re-derive it on demand," was his dogma. And he was right.

Our only defense against numbers is to know what they mean. We must be sure of the source and be able to check any manipulations between source and use. We must know how accurate they are (how many digits are significant) and within what limits. If the math is "too complex" to explain or the sources "not available at the moment," the figures can lie.



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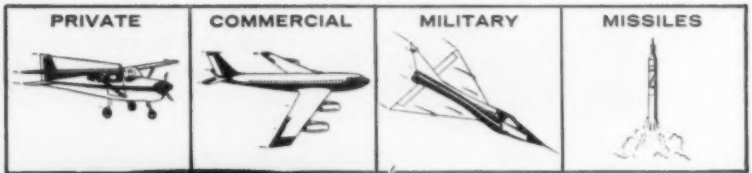

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Product Engineering

November 10, 1958

your guide to

SPRINGS THAT STORE ENERGY BEST

How well a spring can absorb energy depends on its shape and material. Some springs, such as glass-reinforced plastic bars do surprisingly well—better than the workhorses like helicals and cantilevers. Here are equations and two tables that give definite comparisons between many candidates.

Dr KARL W MAIER, *Manager*
Advanced Research and Development Department
Winchester-Western Div, Olin Mathieson Chemical Corp

Springs are often called on to store or absorb energy rather than provide a specific load. Two factors are guides to the best type of spring, or material, for the job:

• **Volume efficiency**—is derived by dividing the energy capacity of the particular spring (or structure) by its volume. Hence it is in equation form and has units of in.-lb/in^3. It allows the energy-absorption capabilities of various materials to be compared easily when the structural shape is considered to be that of a solid bar.

• **Form coefficient**—compares the relative energy-absorption capabilities of various spring types. It is a nondimensional constant, k, that differs with each type, and is based on the value ($k = 1$) for a solid bar under uniform stress.

Two tables have been compiled and are given here: one gives form-coefficient values for 15 spring shapes; the other lists the volume efficiency of 11 spring materials. Volume efficiency of a particular spring can be obtained by combining the values from both tables.

SOLID BARS IN TENSION

Elements of a spring are either stressed in tension (or compression), or in shear. This difference divides springs into two classes: E-springs and G-springs, depending on whether E or G is the modulus of elasticity.

The basic tension element is a rectangular bar (see next page for illustrations of spring shapes, and definition of symbols). Under load P, right angles of the prism remain right angles, while only the length changes. Assuming that the material follows Hooke's law, the geometric and dynamic relationships are then:

Longitudinal strain and stress

$$e = y/L, \quad S = Ee$$

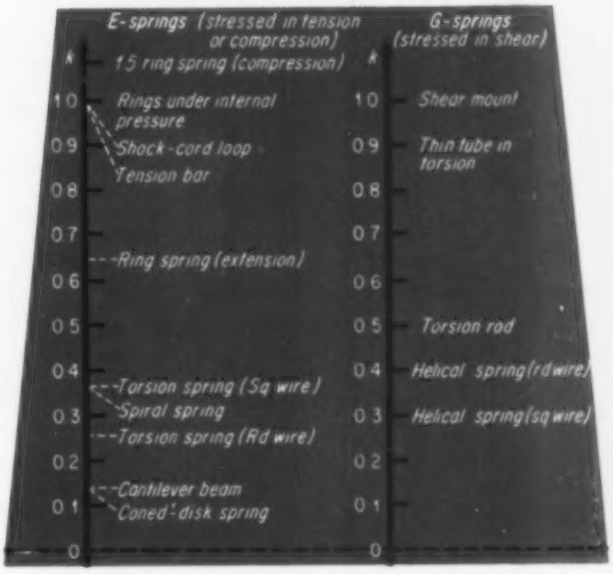
Longitudinal load

$$P = AS = AEy/L$$

Work done in stretching the element is equivalent to the potential energy it contains, measured in in.-lb:

$$W = \frac{Py}{2} = \frac{AEy^2}{2L} = \frac{ALS^2}{2E}$$

TABLE I—FORM COEFFICIENTS OF SPRINGS



Volume efficiency of the springs is obtained by referring the contained energy W to the spring volume $V = AL$. Hence

$$\frac{W}{V} = \frac{S^2}{2E}$$

Therefore, with bars (or springs) of identical shape but of dissimilar material, the bar which can store energy the best is one that has the lowest elastic modulus (least stiffness) and can be stressed to the highest pressure. An alternate formula for volume efficiency is: $W/V = Se/2$. Therefore, a material is a good energy absorber when it can be both stressed and elongated to a high level. The same formulas apply to an element in compression (negative tension) as long as no buckling occurs.

SOLID BARS IN SHEAR

A prismatic element of material under a shear load P uniformly distributed over the two end surfaces will deform into a rhomboidal shape. Defining the shear

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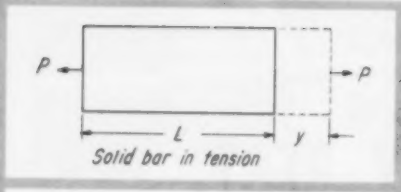
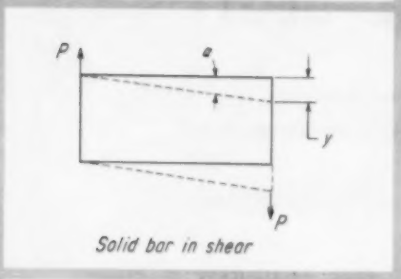
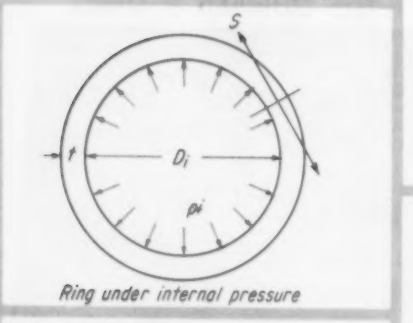


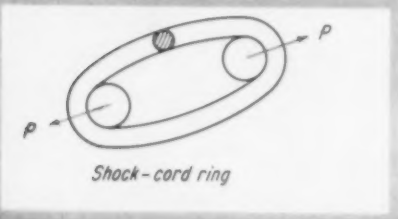
Solid bar in tension



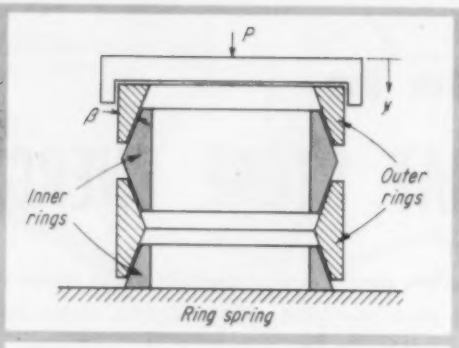
Solid bar in shear



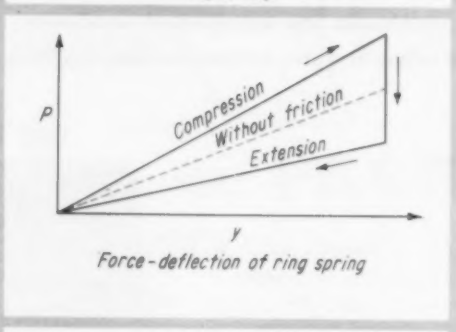
Ring under internal pressure



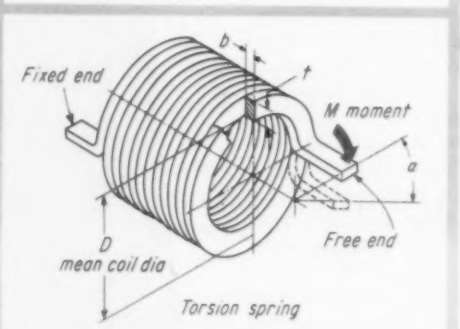
Shock-cord ring



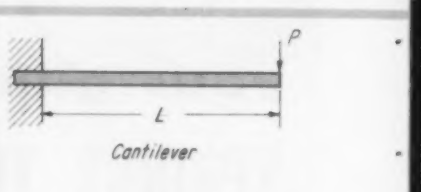
Ring spring



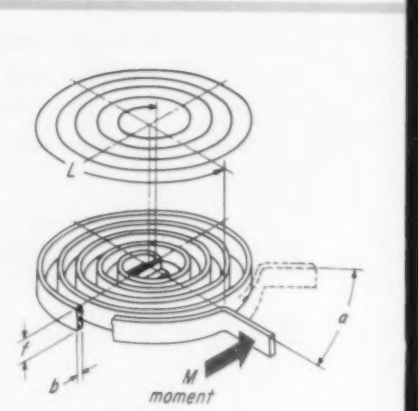
Force-deflection of ring spring



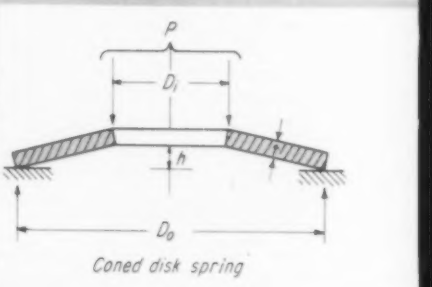
Torsion spring



Cantilever



Spiral spring



Coned disk spring

angle as α and the shift between end surfaces as y, then the geometric and dynamic relationships are:

Shear strain and stress

$$\alpha = y/L, \quad S = G\alpha$$

Work done in deforming the element

$$W = \frac{Py}{2} = \frac{AG\alpha^2}{2L} = \frac{ALS^2}{2G}$$

Volume efficiency

$$\frac{W}{V} = \frac{S^2}{2G} \quad \text{or} \quad \frac{W}{V} = \frac{S\alpha}{2}$$

These formulas are exactly analogous to those of the element in tension, except that modulus of elasticity E is replaced by the modulus of shear G and the shear strain α takes the place of the longitudinal strain e. For high volume efficiency, similar conclusions follow.

FORM COEFFICIENTS

With the majority of springs, the stress distribution is usually not uniform over the spring material, i.e. as with the two simple elements discussed above. Stresses change in magnitude; therefore, the volume efficiency W/V does not come up to the ideal values obtained with a solid bar. Rather, the volume efficiency of an E-type or G-type spring is given the relationship:

$$\frac{W}{V} = k\left(\frac{S^2}{2E}\right) \quad \frac{W}{V} = k\left(\frac{S^2}{2G}\right)$$

Constant k characterizes the influence of spring shape on volume efficiency and is, therefore, suitably designated as the "form coefficient." It directly indicates the efficiency of a spring with respect to a solid bar under uniform stress. In calculating k, and the volume efficiency W/V, inactive material such as the ends of a cantilever beam or the dead coils of a helical spring are not considered.

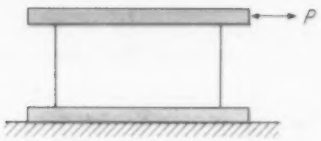
APPLICATION TO E-SPRINGS

Tension Bars of Any Cross-section

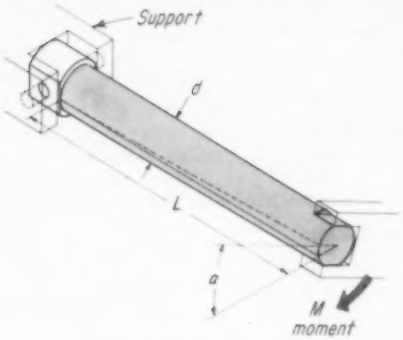
Because all elements of the bar are under uniform tension the volume efficiency is maximum at $W/V = S^2/2E$, and the form coefficient k becomes one.

Metal tension bars are very stiff and therefore seldom

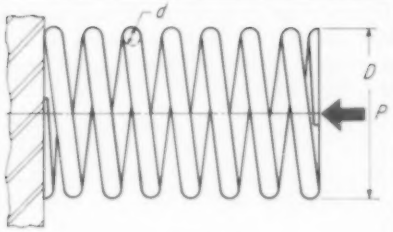
Absorption



Shear mounts



Torsion rod



Helical spring

SYMBOLS

A	—Cross-sectional area, in.²
A_o, A_i	—Cross-sectional area of outer and inner semi-ring
b	—Width of cantilever beam, spiral spring, etc., in.
d	—Wire dia, in.
D_i, D_o	—ID and OD of tube or helical spring, in.
e	—Linear strain, in./in.
E	—Modulus of elasticity in tension, psi
G	—Modulus of elasticity in shear or torsion, psi
h	—Thickness of cantilever beam and depth of coned disks, in.
L	—Length of spring members, in.
k	—Form coefficient
M	—External moment or torque applied to spring, in.-lb
P	—External force applied to spring, lb
p_i	Internal pressure applied to tube, psi
r_o, r_i	Radius of center of gravity (C.G.) of cross-sections of outer and inner ring, in.
S	—Maximum stress occurring in the spring material (both tension and shear), psi
t	—Thickness of stock or wall, in.
T	—Number of turns of a torsion or spiral spring in loading
V	—Volume of active spring material, in.³
W	—Potential energy in spring, in.-lb
W/V	—Volume efficiency of active spring material, in.-lb/in.³
y	—Linear deflection of spring, in.
α	—Shear or torsional strain, radians; also angular deflection in torsion
β	—Taper angle of ring spring, (14° standard)
ρ	—Friction angle, degrees (μ = tan ρ)

used, although capacity of bar shapes to store energy is excellent and good results are obtained if the bars are made of nonmetal materials of low modulus, such as rubber and nylon.

Efficiency of a bar is somewhat reduced by the clamped ends, which contribute little to energy storage.

Rings or Tubes Under Internal Pressure

For a short, thin-walled tube of inner dia D_i and wall thickness t, being submitted to a uniform internal pressure p_i, the uniform hoop stress is

$$S = D_i p_i / 2t$$

Form coefficient is again one. Pressure may be applied by gas, liquid or expanding mandrel. Therefore the tube is a slightly more efficient energy storer than the solid bar because all its material is fully active, although both are listed in Table I as having the same form coefficient.

Elastic Rings Made of Shock Cord

Shock cords are made of multiple-strand elastic (rubber) with braided cotton cover. They are also known as "Aero rings". Elongations of 100 to 200% can be obtained; modulus E is low, in the range of 500 to 2000 psi. Distribution of stress is almost uniform and the form coefficient is, therefore, close to one. Aero rings are employed in aircraft for launching, landing and arresting gear.

Ring Springs

Ring springs have outer and inner rings of matching taper surfaces. Under load the outer rings expand in uniform tension, while the inner rings compress uniformly, permitting a telescoping action.

Friction at the tapered surfaces has a great influence on the dynamics of the spring because of the small taper angle (standard: $\beta = 14°$). The load-deflection rate of a pair of semi-rings in the axial direction is:

$$\frac{P}{y} = \frac{E \tan \beta \tan (\beta \pm \rho)}{\frac{r_o}{A_o} + \frac{r_i}{A_i}}$$

The plus sign applies to the compression stroke (friction and elastic resistance of rings work in same

direction), while the minus sign is valid for the extension stroke (the friction works here against the elasticity of the rings). Thus the mechanical rate of efficiency of the ring spring, i.e., the ratio of energy released to energy supplied is: $\tan(\beta - \rho)/\tan(\beta + \rho)$. For a standard taper angle $\beta = 14°$ and friction angle ρ from 5° to 9°, the mechanical efficiency is from 0.46 to 0.20. Thus 54 to 80% of the initially supplied energy has been converted into heat. Therefore, ring springs have a very high inherent damping.

Form coefficient for a pair of ring springs in compression is

$$k = \frac{\tan(\beta + \rho)}{\tan \beta}$$

During extension, the plus becomes a minus sign and k is from 1.38 to 1.7 in compression and from 0.63 to 0.35 in extension.

Cantilever Beam

Efficiency of a cantilever beam with rectangular cross-section and subjected to a transverse load has been treated recently in detail (see "For Spring Action, Which Cantilever Beam Is Best", Feb 17, p 83). Stress distribution over a cross-section varies linearly, changing from a tension stress at the upper surface to a compression stress of same amount at the lower surface. Along the beam, surface stress increases from zero at the loaded end to its maximum value S at the base.

Load-deflection and load-stress rates are:

$$\frac{P}{y} = \frac{Ebh^3}{4L^3}, \quad \frac{P}{S} = \frac{bh^2}{6L}$$

Energy supplied is $W = 1/2\ Py$ and the spring volume is $V = bhL$, thus the volume efficiency is

$$\frac{W}{V} = \frac{S^2}{18E}$$

This gives a form coefficient k of only 1/9 or 0.11.

Rectangular-wire Torsion Spring

A torsion spring is really stressed in bending; the outer surface is in uniform tension, while the inner surface is in uniform compression. Moment-deflection and moment-stress rates are:

$$\frac{M}{T} = \frac{Ebt^3}{6DN}, \quad \frac{M}{S} = \frac{bt^2}{6}$$

Volume efficiency then becomes:

$$\frac{W}{V} = \frac{S^2}{6E}$$

Therefore, the form coefficient is $k = 0.33$.

Round-wire Torsion Springs

Moment-deflection and stress deflection rates are:

$$\frac{M}{T} = \frac{\pi Ed^4}{32DN}, \quad \frac{M}{S} = \frac{\pi d^3}{32}$$

Volume efficiency then is $W/V = S^2/8E$.

Thus, $k = 0.25$, somewhat less than for the rectangular-wire torsion spring.

Flat Spiral Springs

The entire length of a spiral spring is stressed in bending, with the outer surface being stressed in almost uniform tension. Moment-deflection and stress-deflection rates are:

$$\frac{M}{T} = \frac{\pi Ebt^3}{6L}, \quad \frac{M}{S} = \frac{bt^2}{6}$$

from which the volume efficiency is: $W/V = S^2/6E$.

Thus $k = 0.33$, which is the same as for torsion springs.

Coned-disk Springs (Belleville Washers)

Because one disk produces only a small deflection, a number of the disk springs are usually stacked upon each other. The major stress is a compression stress in circumferential direction, which increases sharply from the outside towards the inside: Load-deflection characteristic is nonlinear and is a function of the diameter ratio D_o/D_i, as well as h/t. Because of their complexities, the formulas are omitted; but the volume efficiency of Belleville washer springs is found to be very low, with k in the range from 0.05 to 0.20.

APPLICATION TO G-SPRINGS

Shear Mounts

A shear mount is usually a prismatic piece of rubber bonded to metal plates on two opposite sides. Coefficient $k = 1$. To produce a worthwhile deflection under load, shear mounts are made from nonmetal materials of low modulus, such as rubber.

Torsion Rods

Within the cross-section of a torsion rod, the shear stress increases in linear proportion to the radius and is maximum at the surface. Moment-deflection and moment-stress rates are

$$\frac{M}{\alpha} = \frac{\pi}{32}\frac{d^4G}{L}, \quad \frac{M}{S} = \frac{\pi d^3}{16}$$

Volume efficiency is then found to be: $S^2/4G$; therefore $k = 0.5$.

Thin Torsion Tubes

Efficiency of a solid torsion rod can be considerably increased by removing its core, which is rather idle in carrying stresses. The moment-deflection rate is then modified to:

$$\frac{M}{\alpha} = \frac{\pi (do^4 - di^4)\, G}{32L}$$

The moment-stress rate is modified in a similar manner. This increases k to as high as 0.9.

Round-wire Compression Springs

Each wire element is stressed in torsion, leading to these relationships:

$$\frac{P}{y} = \frac{Gd^4}{8D^3N}, \quad \frac{P}{S} = \frac{d^3}{8D}$$

$$\frac{W}{V} = \frac{S^2}{4G}$$

This results in $k = 0.5$. However, when the Wahl factor for stress concentration is considered, it can be shown that k is reduced to values as low as 0.35.

Rectangular-wire Compression Springs

Formulas for load-deflection and load-stress rates are omitted because of complexity. Form coefficient of rectangular wire springs is found to be considerably less

TABLE II— MAXIMUM DESIGN STRESS AND VOLUME EFFICIENCY OF SPRING MATERIALS

MATERIAL	TENSION			SHEAR		
	Modulus E, 10^6 psi	Max Design Stress, 1000 psi	Volume Efficiency, in.-lb/in.^{3}	Modulus G, 10^6 psi	Max Design Stress, 1000 psi	Volume Efficiency, in.-lb/in.^{3}
Music wire, ASTM A228-47	30	150–350	375–2042	11.5	90–180	352–1409
Oil-temp spring wire, ASTM A229-47	30	120–250	240–1042	11.5	80–130	278–735
Valve spring wire, ASTM A230-47	30	120–210	240–735	11.5	80–125	278–679
Chrome-silicon steel, SAE 9254	30	220–300	807–1500	11.5	130–160	735–1113
Hot-rolled bars, SAE 1085	30	115–150	220–375	11.5	75–110	245–526
Flat spring steel, SAE 1060	30	120–180	240–540	....	Not used	.....
Clock-spring steel, SAE 1095	30	150–310	375–1602	....	Not used	.....
Stainless-steel wire, SAE 30316	28	60–260	64–1207	10	45–140	101–980
Phosphor-bronze wire, SAE 81	15	60–110	120–403	6.5	50–85	192–556
Shock cord, (rubber filaments)	.002	2	1000	....	Not used	.....
Parallel glass-fiber, plastics	6	120–150	1200–1875	....	Not used	.....

than that of round wire compression springs and is usually in the range from 0.26 to 0.33, with $k = 0.31$ for square-wire springs.

INFLUENCE OF MATERIAL PROPERTIES

Volume efficiency of a spring material depends on two properties: (1) Modulus of elasticity (E or G)—low moduli give high volume efficiencies; (2) maximum design stress of the material—high stress capacities increase volume efficiencies.

Data on the moduli, the maximum design stress, and on the maximum possible volume efficiency have been gathered from various sources for 11 spring materials and compiled in Table II. Because the maximum design stress depends considerably on the size of the wire or the thickness of the flat strip, it is given by a range of values, rather than by one figure only.

Metal Spring Materials

Here is how the metals stack up against each other. The field is dominated by steel, with cold-drawn music wire, clock spring steel and alloy spring steels having the best volume efficiencies. Stainless steel wire and phosphor bronze wire are of somewhat lower efficiency, but have the added advantage of greater corrosion resistance.

In general, spring materials have a somewhat higher volume efficiency when stressed in tension rather than in torsion. The volume efficiencies in tension range up to 2040 in. lb/in.^{3} while in torsion the values go up to 1409 in.-lb/in.^{3}. However, hot-rolled bars and the non-ferrous spring materials show the opposite behavior.

Stress values in the table were obtained from the "SAE Manual on Design and Application of Helical and Spiral Springs" (SAE Standards TR-9). These values represent upper limits because Ordnance usually specifies the best of materials. It is therefore wise to stay somewhat below these values in conventional designs.

Nonmetal Spring Materials

This is a very promising field. A few examples have been included in Table II to bring attention to the advantages of nonmetals. Values are only approximate.

Shock Cord

These data were obtained from the Russell Mfg Co, Middletown, Conn. A sample ring of 13/16-in. dia had an average modulus of 2000 psi and an elastic elongation of at least 100%, resulting in a 2000-psi maximum design stress, and a volume efficiency of 1000 in.-lb/in.^{3}. This performance is comparable to the best of spring steels (in that size), while the weight is only a fraction that of steel.

Reinforced Plastics

Glass-fiber-reinforced plastic of unidirectional fiber pattern and high glass density have a modulus of elasticity of 3,000,000 to 6,000,000 psi and take an elastic elongation of 3% or more. Assuming a modulus E of 6,000,000 psi and maximum design stresses of from 120,000 to 150,000 psi, a very high volume efficiency of 1200 to 1875 in.-lb./in.^{3} (i.e. 100 to 156 ft-lb/in.^{3}) is found. This performance is superior to steel springs at much less weight.

REPRINT of this article can be obtained for your reference file by checking E48 on one of the Reader Service cards bound in this issue. For further reprints available see "Current Reprints" listing in this issue on page 169.

EDITOR'S NOTE: The need for springs with high energy efficiency has led to improvements in these categories:

- Cantilevers with modified shapes—see "For Spring Action . . . Which Cantilever Is Best," Feb 17, p 83.
- Cantilevers with modified supports—see "Cantilever Springs That Roll with the Load," July 7, p 58.
- Series-assembled springs—see "How to Design Multi-rate Helical Springs," Jan 20, p 76.

What you should know about DESIGNING for RELIABILITY

It isn't enough that the equipment works. It's got to work again and again—sometimes under very difficult conditions. Author explains the reliability concept and offers tips for avoiding designs that will give trouble.

Dr DIMITRIS N CHORAFAS
IBM World Trade Corp, and
The Catholic University of America

In a recent appraisal of the US missile program, Dr. Theodore von Karman, well-known aeronautical scientist, claimed that overdesign at the expense of reliability is behind many missile failures. Engineers, he said, try to get too much out of a system. It would be better to settle for 10% less performance—because when design specifications get too tight, reliability suffers.

Missiles and military gear are not the only areas where reliability is important. If a production line has to shut down temporarily because a spring breaks or a poorly lubricated slide sticks, the line may operate in the red for that month. Even consumer products must be thoroughly tested for reliability. The consumer will subject products to hard use and put them to work on jobs they were never designed to do.

Mechanical reliability

Electronic components and systems are commonly analyzed for reliability, but mechanical systems can malfunction too. Bearings fail, as do electron tubes; gears wear, mating parts seize, structural members fracture under extreme environmental conditions. Mechanical parts, in short, have a life expectancy just as do electronic parts and can be tested for reliability too.

Reliability is a modern concept in engineering. It can be defined as "freedom from failure" or "the probability of adequate performance for a specified time under specified conditions." But to have scientific significance it must be assigned an exact, and above all, measurable meaning. In a technical definition, the essential concept of reliability is "probability of success," and probability is a statistical concept. So it is necessary to measure reliability by statistical techniques and reliability reports must include sample size, limits, and sampling procedures.

How it's measured

Because reliability is a probability, the common statistical notation is given to designate reliability of a system or component. But what does a reliability figure of 0.99 mean? Obviously, 0.99 is better than 0.77, but does it mean the equipment will operate 99 times out of 100 when it is turned on; or that if in operation, there is a 0.99 chance it will keep on running for a certain length of time? Something else is needed—an element of time must enter the picture.

The generally accepted measure is Mean Time Between Failures ($\overline{T}$). Reliability then becomes "probability of obtaining failure-free operation for a specified period of time." If failure rate is constant per unit time; that is, if a certain percentage of the units under test fail every hour, probability of failure can be expressed as an exponential curve

$$P = e^{\frac{-t}{\overline{T}}}$$

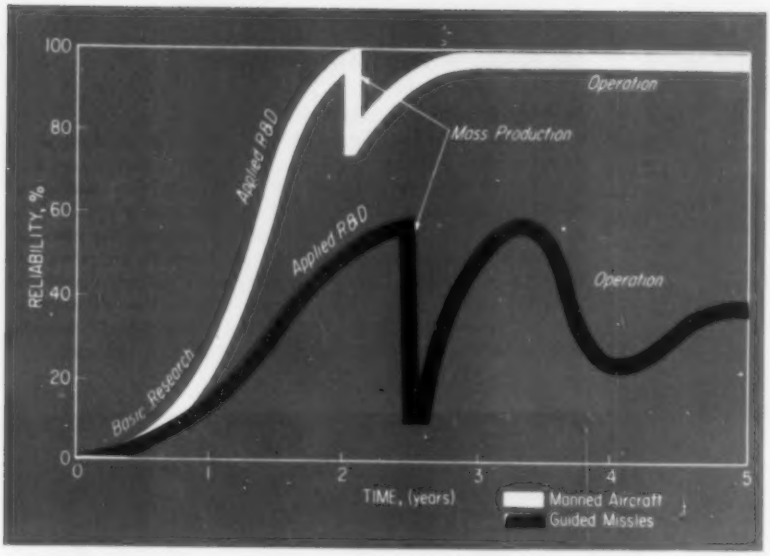
where P is probability of operating for time t. When t equals $\overline{T}$, P is only 0.37, showing there is really a very low probability that equipment will not fail before its Mean Time Between Failures.

It becomes clear that any component or system following the exponential life curve must have a $\overline{T}$ value many times greater than required failure-free life. If, for example, a component must have a 95% chance of lasting three hours, $\overline{T}$ for that component must exceed 58 hours. Also, reliability of individual components must be far greater than required reliability for the over-all system. Statistical theory shows that if every component of a 500-component system is 99% reliable, the system will be only 1% reliable.

Theoretical vs actual

Historical data of actual equipment shows, in some instances, remarkable agreement with the exponential life curve. Hughes Aircraft Co published a reliability report including a plot of field data showing that failures of particular airborne radar equipment closely approached the ideal curve. And studies at Vitro Laboratories, based on a large number of shipboard electronic equipment failures give a plot showing a $\overline{T}$ value of 165.8 hours and a corresponding 95% probability of about 8.4 hours.

Reliability studies can be made at any point in a new-product development program—from initial stages of research to the point where the product ultimately becomes operational. A program aimed toward prevention of unreliability in early phases, rather than detection after final design and development, will help a designer concentrate on types of changes which yield most significant improvements. This requires the following steps: (1) make and test a mathematical or physical model,



Reliability grows irregularly . . . from a smooth rise to point where mass production causes a sharp drop. Curves for manned aircraft and guided missiles have roughly this shape.

HERE'S WHERE TO LOOK FOR UNRELIABILITY

Sandia Corporation, Albuquerque, New Mexico, recently conducted a survey at suppliers' plants to determine whether or not manufacturing processes were adequate to assure a product of satisfactory quality and reliability. Reasons believed responsible for processing failure are listed below in decreasing order of occurrence, not necessarily in order or importance. Percentage figures refer to observed infractions as compared with total situations where infractions were possible.

- Test equipment or gages not regularly compared with standard 72%
- Inadequate identification or control of material in process 52%
- Inadequate inspection records and reports (including information on process improvement) 36%
- Sampling plans not adequate—plans not statistically sound, or plans that didn't allow for human judgment or error 25%
- Lack of materials-testing for conformity and acceptance 25%
- Materials used before certification was available 25%
- Inspection requirements of plans not being followed .. 25%
- Inadequate inspection instructions—important characteristics not inspected or improperly inspected .. 18%
- No regular use of inspection reports to improve process 18%
- Production personnel inspecting their own work—lack of separate inspection 14%

(2) start laboratory tests with most basic parts, (3) increase complexity to higher-order assemblies and test again, (4) make full-scale model and test it to failure, (5) make reliability predictions.

Too much vs too little

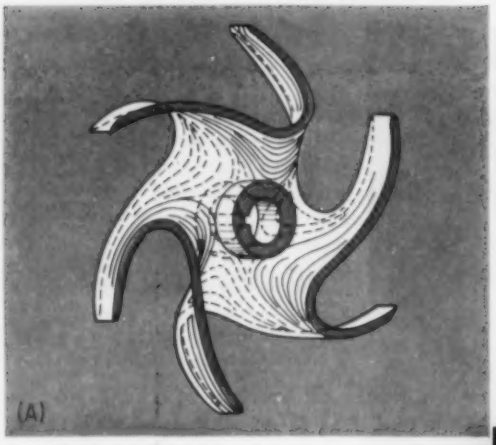
Although high reliability is a desirable quality, there are practical limits determined by nature of the system and the mission it's designed to accomplish. As in any other engineering decision, compromises restrict the extent to which the program can be carried; the advantages of high reliability must be played off against disadvantages of system complexity, high cost and increased development time.

It is a poorly designed product that has some components that break or fail at time t and others that work satisfactorily until time 50 t. It is also a waste of time and money to fashion products that will have considerable useful life after they have become obsolete. Unnecessarily high reliability may be as bad in terms of final results as low reliability. The German V-2, in World War II, achieved the very high reliability of 78%. Three thousand were test-fired over a period of four years—the greatly improved model was delivered too late to be of strategic value.

Start with reliability

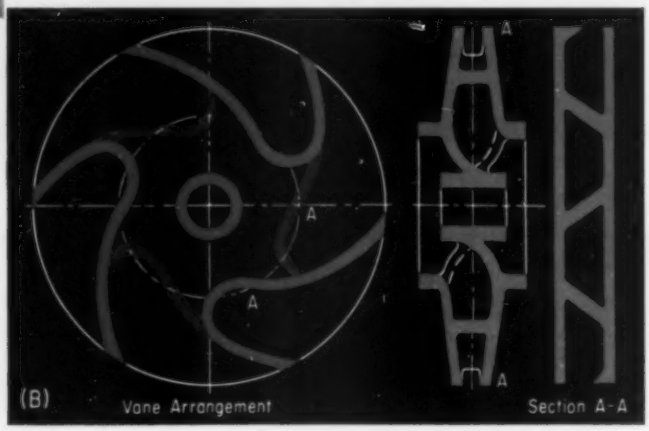
Best results depend on a designer who has oriented his thinking toward sound fundamentals of reliable design. Before drawing his first line, he should review these basic concepts.

- A system with a large number of simple items is preferred to one with a smaller number of complex items. Over-all reliability decreases sharply within increasing complexity; roughly, it is inversely proportional to the square of number components.
- It is much more difficult, expensive and time-consuming to increase the level of component reliability in the region of 99.9% than in the region of 99% or 90%.
- It is better to accept certain penalties to get flexibility than to make the unit utterly inflexible.
- Build-in "absorption points" (limit switches, fuses, overload clutches) as barriers to trouble.
- Reinforce weak points in the system with built-in redundancy.
- Provide displays or indicators to signal impending failure or approaching end of life. ■



THE NEW, TWISTED-VANE IMPELLERS

In both Swedish designs . . .
thinner vanes help keep weight down. Open design (A) and closed design (B) both show how front face is identical to back except that it is rotated 60° out of phase. Design is mixed-flow (half-axial, half-radial) because vane-inlet surfaces on both sides are essentially at right angles to drive shaft and outlets are parallel. The direction of twist changes for alternate vanes, as shown in circumferential section A-A of design (B); vanes must therefore be paired and will come out an even number. Such design is better than an ordinary 2-sided impeller (two single-inlet impellers back-to-back) because dividing wall is eliminated and number of inlets is reduced.



the design twist that gives better non-clogging CENTRIFUGAL PUMPS

A special impeller is needed when a centrifugal pump has to handle pulpy liquids. Here's how new designs from Sweden compare with other special types that won't get fouled up.

T YGGE, *Chief, Pump Dept*
A B Skogland and Olsen Co, Gavle, Sweden

Above are two impellers that give a new approach to the problem of keeping liquid flowing freely through a centrifugal pump. These twisted-vane types are compared with two older special designs. Of course, all centrifugal impellers are built to give free flow. But special shapes are often needed to completely prevent any buildup of stringy or pulpy solids. Such non-clog impellers range from special variations of the simple radial type to combinations such as axial-to-radial.

All four specials illustrated here share the same basics. Each has a limited number of vanes, kept as thin and smooth as possible to reduce resistance. The vane inlets and pump casings are shaped to throw off debris, and flow areas are kept large.

A new twist

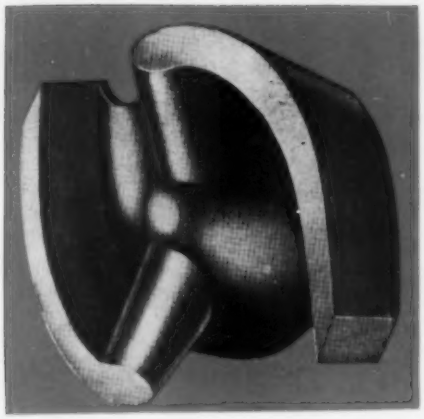
Although the two older clog-free designs can do the job, they are bulky. Therefore their hydraulic radius (ratio of flow area to wetted perimeter) is low—tending to increase their resistance to flow and to lower their efficiency.

By contrast, the twisted-vane designs have these two advantages:

1) thinner vane sections, fewer struts and an inlet that is more circular—improving performance by increasing the hydraulic radius;

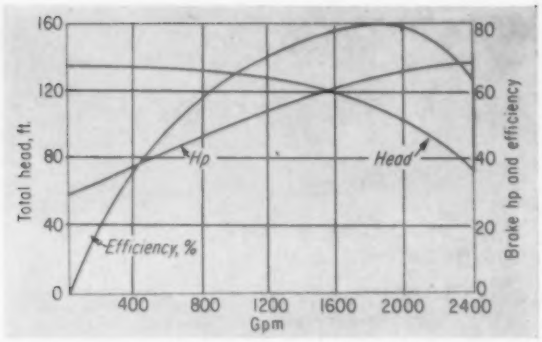
2) symmetrical shape (the front is same as the back) so each vane can serve both sides of the impeller.

Manufacturing costs will be less because of reduced

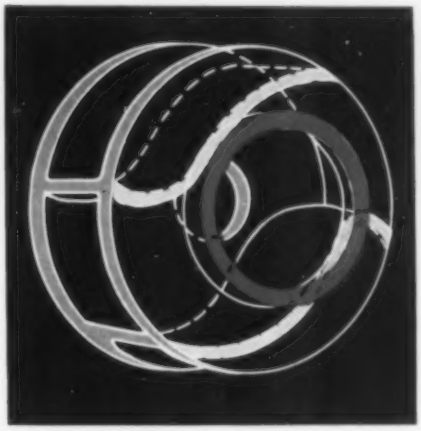


OTHER NON-CLOG IMPELLERS

This open type . . .
has heavier vanes and is single-sided but can have inlets on both sides. The thicker vanes, however, cause some loss of effective pumping area. A wearing plate in the pump casing goes against face of impeller and serves to break up accumulation of lumps in fluid.



Water tests . . .
on the new impellers (6-vane type) run at 1450 rpm, indicate efficiencies as good as those common with conventional centrifugal design. The new non-clog types will also pump up to 9% concentration of paper pulp in water, but efficiencies will be less because solid matter cannot convert its kinetic flow energy into pressure energy.



Half the periphery . . .
is inactive for this closed type; but sharp edges are eliminated, only two vanes are required, and wide passage areas are obtained. Efficiency is reduced because of eddying in nonpumping regions behind each vane. Impeller is overhung from bearings and is more difficult to balance.

weight, simpler casting and machining, and easier cleaning of flow channels.

Specific Speed Indicates Efficiency

The new impellers have high efficiency partly because favorable combinations of speed, flow and pressure were selected. This combination, called "specific speed," is equivalent to the number of rpm required to pump 1 gpm against a 1-ft head. The equation for specific speed is:

$$N_s = \frac{(\text{rpm})\ (\text{gpm})^{1/2}}{(\text{head, ft})^{3/4}}, \text{ actual}$$

Higher specific speed usually gives higher efficiency. For example, in either of the new impellers–each is a 2-inlet design–it pays to combine the two flows because calculated N_s is higher. If passages were kept separate, then N_s would be calculated with half the total flow for each side, and value would be less.

Priming Improved

In ordinary centrifugal pumps, not designed for self-priming, air pockets may form and end the centrifugal action. With the new designs, if air pockets form on one face of the impeller, the opposite face will continue to pump into the outlet casing. Part of the fluid will then spill into the air pocket and, as it is thrown out again, bring some air with it. Ordinary double-sided impellers will also do this, but the dividing wall must extend to the periphery for best results–and this gives extremely small vane outlet areas, reducing efficiency.

EDITOR'S NOTE: Selecting pumps involves more than knowing the general type needed—specific performance requirements and costs are also important. "Centrifugal Pump Selection," Mid-Oct '57, p J17, outlines the entire selection procedure and helps decide if a non-clogging pump should be specified.

Positive-displacement pumps also solve many dirty-fluid pumping problems. "Hydraulic Pumps," July '55, p 132, compares gear, vane and piston pumps on bases of mechanical design, control, performance and fluid contamination; and "13 Rotary Pump Mechanisms," June '57, p 180, illustrates and briefly describes special pumps such as pivoted-vane, disk, Roots, screw, oscillating arm and flap-valve.

Theory on how viscosity affects efficiency is provided in "Optimum Clearances in Pumps and Hydraulic Motors," Mid-Oct '55, p J6, and equations are derived for laminar flow between parallel plates.

See cover picture for this view in full color

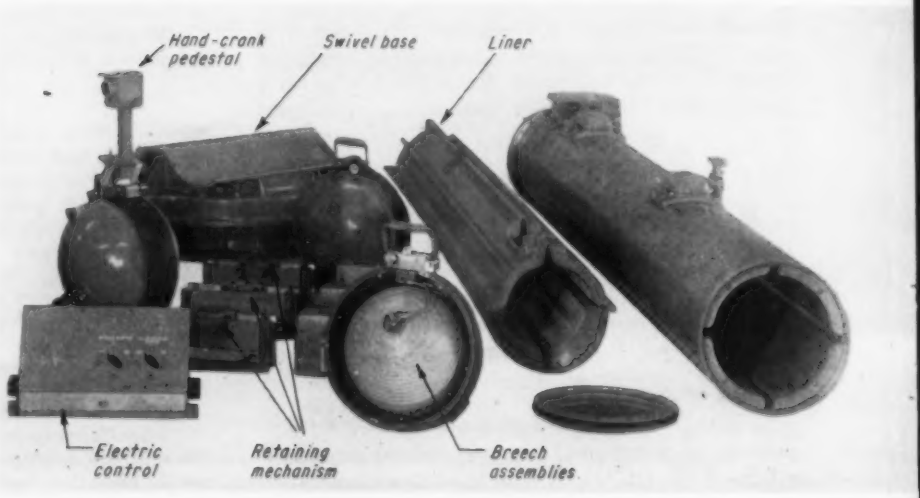
PLASTICS HURL US NAVY TORPEDOES

This 3-shot launcher illustrates ways that fiberglass-reinforced plastics can be shaped for different purposes. The same base material here built the pressure bottle that kicks off the torpedo, the liner that allows firing a smaller-dia projectile —and also built the torpedo tube itself.

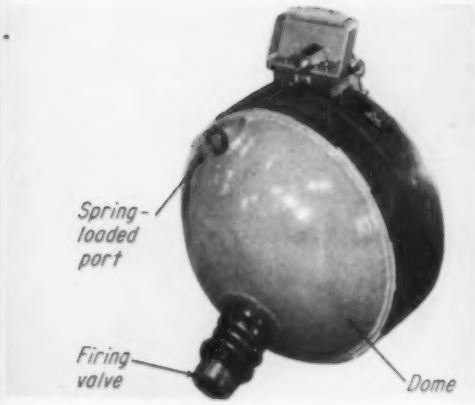
Corrosion resistance, high strength and simplified fabrication are three excellent reasons for turning to plastics here, but wartime scarcity of other materials was another important incentive. Self-contained air supply simplifies installation; only external power source needed is an electrical connection. Resulting launcher, the Mark 32, becomes a natural for small naval craft. It is produced by Apex Reinforced Plastics Div of White Sewing Machine Corp, Cleveland.

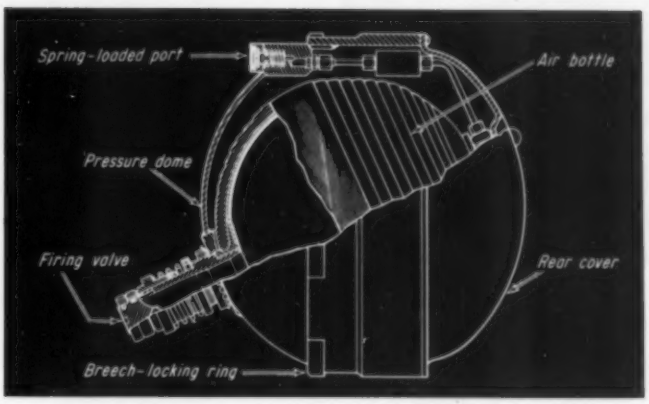
Torpedo launcher . . .
is built upon swivel base with cradle for two lower torpedo tubes. Aluminum brackets bolted between them hold the third tube. Hand crank mounts at rear of tubes. Connected to worm and wheel in base, it swings tubes to firing position. Interlocks in base prevent firing if tubes are pointed fore and aft.

Torpedo-retaining mechanism contains an air cylinder that kicks firing valve open and releases torpedo when firing button is pressed. Electrical control box provides connections for heaters used in tubes and base. Heater keeps joint between fixed and rotating portions of base free of ice. Protective cover closes forward end of tube.



IN NEW PRODUCTS



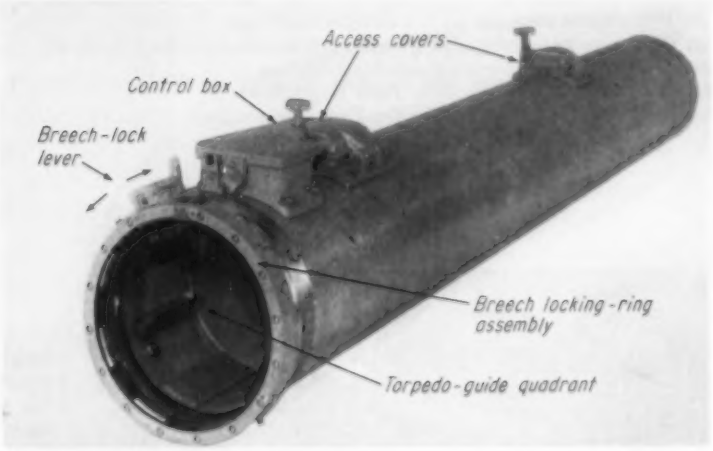


Breech assembly . . .
provides pneumatic power to launch torpedo. Here, too, heart of unit is reinforced plastic—a 900-cu in. fiberglass bottle containing air at 2000 psi. Bottle is filament-wound of fiberglass and epoxy resin. Continuous filaments have tensile strength of 140-150 x 10^3 psi, but a laminate of this type is reduced to 70 x 10^3 psi because its strength must be equal in all directions.

When firing valve is opened at launching, the pressure bottle's full 2000-psi thrust hits rear of torpedo. Heavy-gage aluminum dome, welded to breech ring, retains air in tube during firing. Protecting and supporting the bottle is a rear cover, also of fiberglass, but matched-metal-molded for economy. Spring-loaded port supplies air to firing circuit after breech is locked.

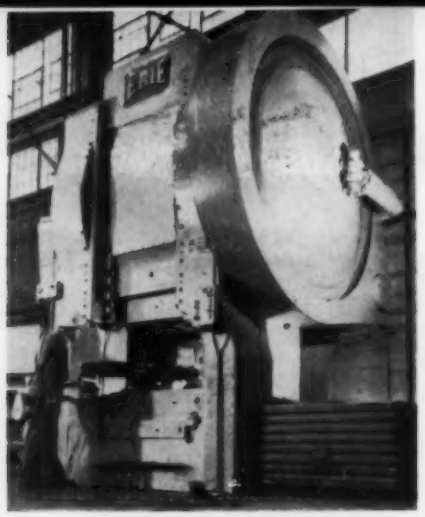
Tube also handles . . .
10-in.-dia. torpedoes. This requires inserting a liner approximately 10 ft long and 1 ft across. It is made of fiberglass mat that is matched-metal-molded, bonded with epoxy adhesive, and riveted along edges. Used here are continuous filaments cut into 2-in. lengths. Ratio of 35% glass to 65% resin gives 14,000-psi tensile strength.

Opening at top of liner is aligned with rear access door for torpedo adjustments. Liner is locked in tube by slot and spring-loaded knob on rear access-door assembly. Conical profile on bottom sections of liner guides torpedo into place, and openings give clearance for torpedo fins.



Tube assembly . . .
is 11 ft long, 16⅜ in. OD, ½ in. thick. Base material here is fiberglass centrifugally spun into mat that becomes straight tubing of uniform diameter and wall thickness. Impregnated with flame-retardant polyester resin, the tube is heat-cured while spinning at 800 rpm.

Four quadrants are bolted to inner surface of the tube to guide 12¾-in. torpedoes. Heating elements bonded to the quadrant maintain a protective 50-F minimum temperature for the torpedo. Breech locking-ring is bonded with epoxy adhesive and bolted to the tube. Access-covers permit adjustments to be made to torpedo while in tube. Control box provides both electric and manual firing circuits. Breech lock lever rotates approximately 3 in. to lock breech assembly to tube.



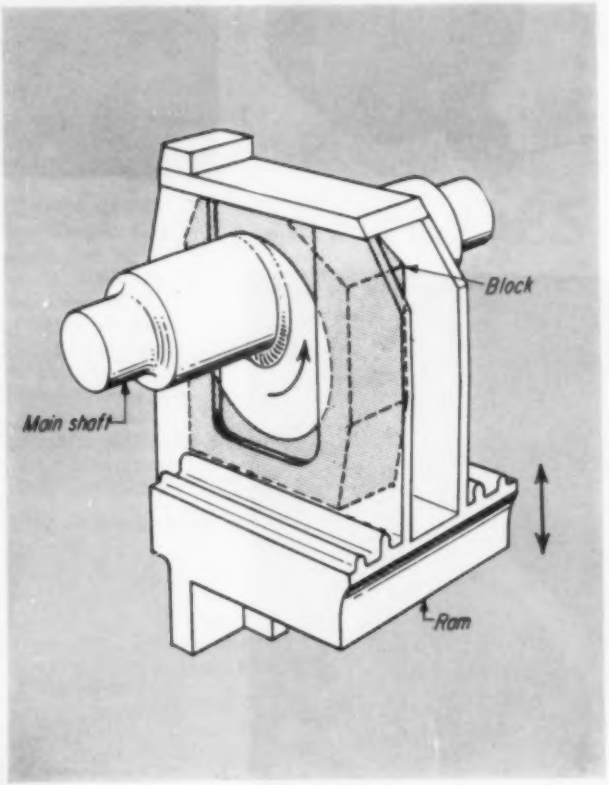
Shortened Press Reduces STRETCH

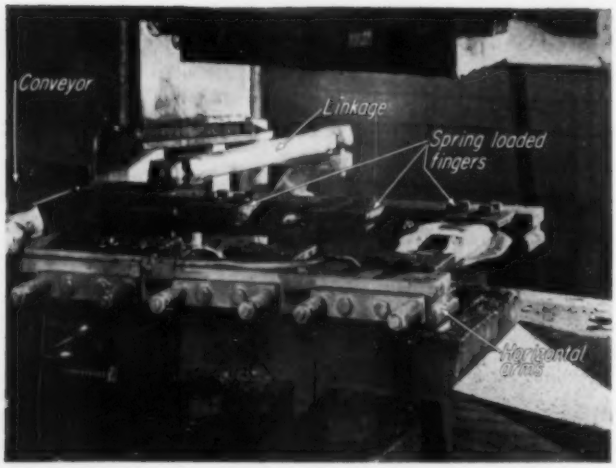
Thanks to scotch yoke that transmits thrust, this automated forging press also has shorter, stiffer frame. Auxiliary guides eliminate need for guide pins in die sets.

The high-volume 2500-ton press is designed to shape such parts as connecting rods, tractor track links, and wheel hubs. Simple automatic-feed mechanism raises production to a possible 2400 forgings per hour. Produced by Erie Foundry Co, Erie, Penna.

Ram action . . .
is provided by mainshaft eccentric working through a scotch-yoke setup. This consists of a rectangular block, mounted on the eccentric and located between two horizontal ways in the ram. The block transmits vertical component of eccentric action directly to the ram. Ram moves between bronze guides, transmitting thrust to top of the die. Contact surfaces between ram and block run submerged in oil. Ram extends above mainshaft centerline, providing long guides that reduce angular cocking of ram.

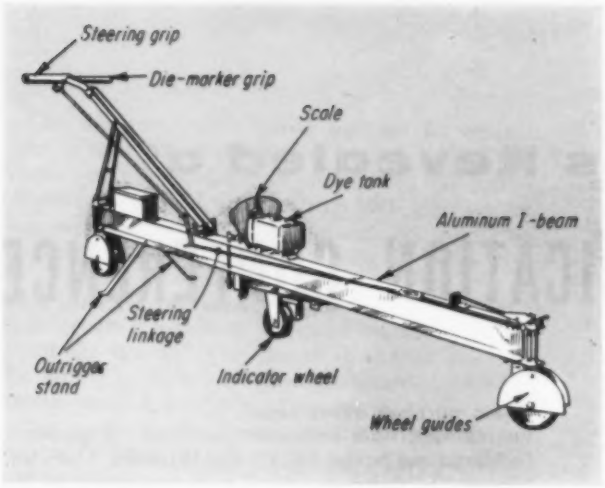
Doing away with a pitman reduces over-all press height more than 3 ft—a practical asset in press operation. Because stretch of side members and compression of pitman arm is considerable in heavy-duty presses, some of the flywheel energy goes to creating this deflection rather than doing useful work.





Forging temperatures . . .
of 2000 to 2400 F and scale-flaking conditions are problems that make hot-press automation difficult. Here, linkages are installed outside high-temperature work area. Conveyor delivers hot bar stock from furnace to press; pusher positions bar at pickup station. Horizontal arms then move in; spring-loaded fingers clamp bars and shift it to first die. As upper die comes down, arms move out and return to starting position. Cycle is repeated, progressively advancing forging through dies to ejection chute. A trimming station can be added if desired.

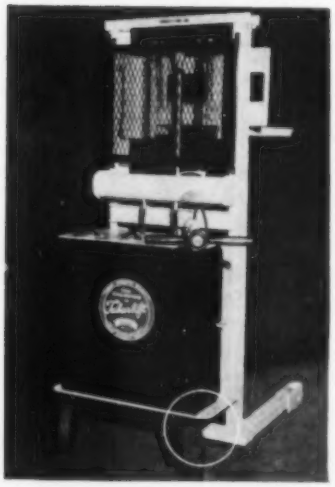
The mainshaft eccentric chain-drives the automatic feed to insure accurate timing. Kick-out pins are operated by a cam on the mainshaft, and lift the forging from die at end of press stroke.



Magnifying the bumps . . .
detects irregularities in road surface. Any up-and-down variations affecting center wheel are magnified 20 times on a large scale that gives ½-in. readings. Operator can then dye-mark areas that don't meet specifications. Aluminum beam rolls on ball bearings and rubber-tired aluminum wheels. Dye-marker is controlled by left-hand squeeze grip; steering, by twisting right-hand grip.

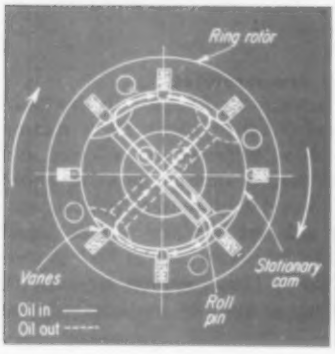
Straightedge for Highways

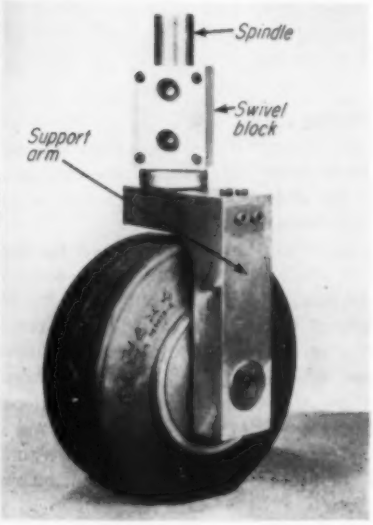
The inspector walks but three wheels carry the rapid tester for surface variations of new concrete and blacktop slabs. The center wheel indicates high or low spots. Produced by Viking Mfg Co, Manhattan, Kans.



Pump Powers Truck Wheel

It runs fist-sized hydraulic motor that fits in hub of wheel and self-propels this lift truck built by Uhrden Inc, Dennison, Ohio. The "Hydro-wheel" is produced by Mechanisms Co, Uhrichsville, Ohio.





Flow path of oil . . .
begins at hydraulic pump used for the lift mechanism. Oil from pump goes through spindle and swivel block bolted to truck frame, then through support arm to stationary axle. Hollow roll-pin keys the cam and axle together, allowing oil to reach cam ports. Oil pressure on spring-loaded vanes in ring rotor rotates the wheel. Pressure-relief valve can be set to limit the wheel's torque output, protecting battery and motor from overload.

New Techniques Revealed at

WEST COAST LUBRICATION CONFERENCE

Radioactive tracers, interference microscopy and high-speed computers are making strong headway in bearing and lubrication research. Sixteen of the 26 papers presented at the ASLE/ASME Lubrication Conference in Los Angeles, Oct 13-15, are reviewed here by a well-known specialist from MIT.

Copies of papers with prefix "LC" can be obtained from the American Society of Lubrication Engineers, 84 E Randolph St, Chicago 1 (50¢ apiece to members, 75¢ to others); papers with prefix "LUB", from the American Society of Mechanical Engineers, 29 W 39th St, New York 18 (25¢ to members, 50¢ to others).

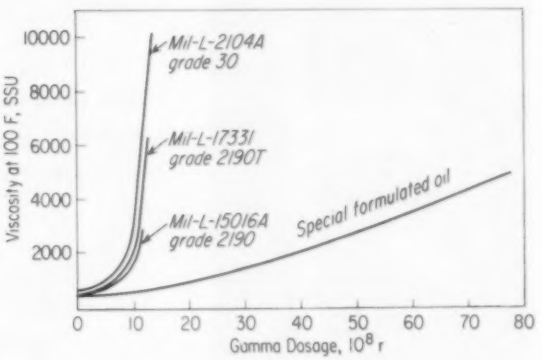
ERNEST RABINOWICZ
Lubrication Laboratory, Massachusetts Institute of Technology

Papers presented at the fifth annual ASME-ASLE Lubrication Conference disclosed the keen interest that engineers and industry are showing these days in the following three approaches to the problem of improving lubrication:

- **Lubrication under unusual conditions,** either at very low temperatures (down to the liquid hydrogen range), or up to 1800 F, or alternatively in the presence of strong radiation. Papers in this category point out the vastly more varied environments encountered by the lubrication engineer today, as against the more standard conditions of only a few years ago.
- **Re-evaluation of fundamental laws** of friction, lubrication and wear. No spectacular new theories were presented but the papers revealed the strengths and weaknesses of currently accepted explanations of friction and wear.
- **New experimental tools** of the most advanced type are now being used for routine research: for example, radiotracer techniques for wear studies, and high-speed digital computers for hydrodynamic bearing design.

Liquid nitrogen offers hope . . .
for subtemperature lubrication problems. Experiments by Martin and Jacobs (LC-13) and Wisander, Maley and Johnson (LC-9) suggest that liquid nitrogen, while not in the conventional sense a boundary lubricant, does allow sliding and rolling to occur without seizing and severe welding–at any rate under lightly loaded conditions. The stainless steel alloy 440C in particular has proved suitable.

Why high radiation dosages . . .
turn ordinary lubricating oils into brittle solids on prolonged exposure is reported by Carroll and Bolt (LC-1). But specially formulated oils based on alkyl aromatics can take exposures five times as great without losing their liquid character.



Tests show it is now possible to use organic lubricants for sliding members, such as control rods, which must operate in parts of a nuclear pile.

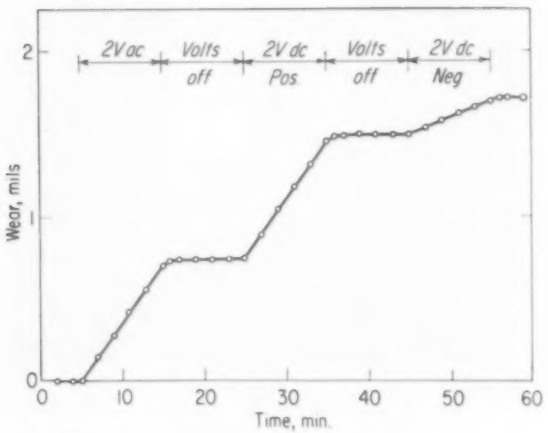
One-shot oil for high temperatures . . .
is one way to avoid chemical breakdown. In this technique reported by Gray (LUB-10), fresh oil is sprayed as a jet against the bearing surface–then collected and rejected. Other developments showing promise, above 800 F where standard liquid lubricants and sliding surfaces do not perform well, are the new organic liquid phthalocyanine, and solid lubricants such as PbO or mixtures of graphite and CdO. These powders are worn off the surface during sliding, so must be continually blown into the bearing.

Gray also investigated bearing materials for temperatures up to 1000 F; found tool steel is still the best type. Sintered-carbide materials gave good results, too—because of resistance to oxidation—but tests with titanium carbide indicated brittleness that can cause trouble when it is used for roller bearings.

New solutions to Reynold's equation . . .
in programmed form have revitalized research in gas and liquid film bearing. This class of lubrication problems, the earliest to be scientifically investigated, is still vigorously pursued, as shown by the six papers presented. A big reason for the present interest in gas-lubricated bearings is their favorable high-temperature properties, but calculations are more complicated than with liquids. The programmed solutions replace tedious testing for determinations of fluid stiffness, dissipation functions, and other parameters that interest design engineers. Four papers using these techniques were presented: full journal bearings, (Sternlicht, LUB-3); partial journal bearings, (Raimondi, LC-4); 3-lobe bearing (Pinkus, LUB-2); and circular step-bearing, (Licht, LUB-1). Calculated solutions check well with the experimental tests.

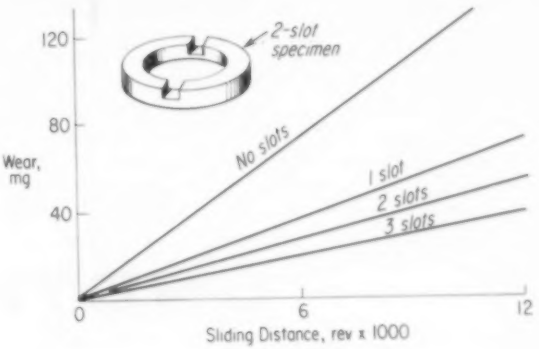
A different but related problem is discovering the function in automotive oils of the widely used anti-wear additive, zinc dialkyl dithiophosphate. Two papers related how this problem was investigated: one by Furey (58 LC-12), using radiotracers; and one by Bennett (58 LC-11), using interference microscopy. Their conclusion—action of this additive on metal surfaces is very complex, and requires further experimental work.

Can wear be reduced by negative voltage? . . .
Tests by Kaufman and Boyd (LC-10) on the pitting of tin-base metal against steel, produced by arcing, found that a negative voltage on the babbitt produces a lower rate of wear than does an equal positive voltage.



This offers the possibility of reducing pitting wear by superposing negative voltage on top of ac—if the latter cannot be avoided.

Slotting a metal surface reduces wear . . .
reports Steijn (LUB-8 and 9). He slid a radioactive surface on a nonradioactive one so that wear and transfer could be measured. Surprising discovery was—when sliding brass rings against each other, the rings being identical except that some had small radial slots—wear rates differed by factors of more than 3 in some cases.



Such results suggest sliding systems with slotting to diminish wear of one surface at the expense of another that is easier to replace.

Materials with low surface energy . . .
have low frictional resistance at high temperatures. Sliding experiments to 1000 C by Kingsbury and Rabinowicz (LUB-6), using zinc, copper, titanium and 1020 steel, suggest that materials with a low W/p ratio—where W is the surface energy and p the hardness—have favorable friction properties.

Adhesion theory of friction . . .
will explain why adhesion between metal surfaces—cause of galling and seizure—depends on load and time of contact, reports Mason (LC-7). This problem turns out to be closely related to proper functioning of solderless-wrapped electrical connections.

Do gears have thin lubricating film . . .
at all times during operation? With radioactive techniques, Borsoff (LUB-4) proved existence of a thick film formed between gears operating under normal conditions, and a very thin boundary layer when gears are operated at high loads. However, with heavy pressure, the film breaks, the gears touch momentarily, welding and failure result. Extreme-pressure agents are required to maintain the film.

EDITOR'S NOTE: Mr. Rabinowicz has recently played a major role in developing simple, general equations for predicting the magnitude of wear of metals. For details, see "New Coefficients Predict Wear of Metal Parts," June 23 '58, p 71. In addition, he evaluated for PRODUCT ENGINEERING (Nov 25 '57, p82) many of the papers presented at the 1957 London Conference on Lubrication and Wear.

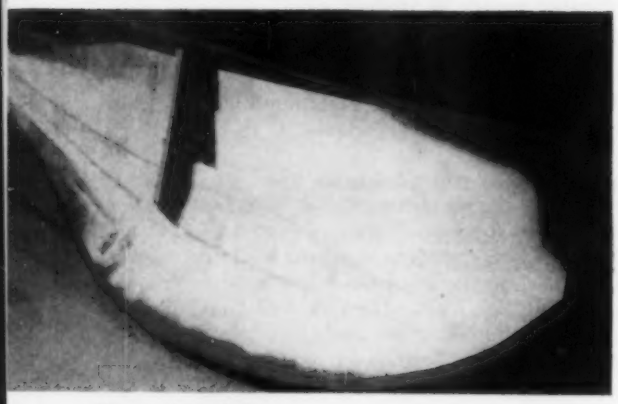
What about polyurethane for strong, lightweight parts? The "cake-mix" method will handle this rigid foam plastic but calls for knowing the latest about cavity design, formula choice, production controls. Here's the . . .

BEST RECIPE for CASTING URETHANE FOAM

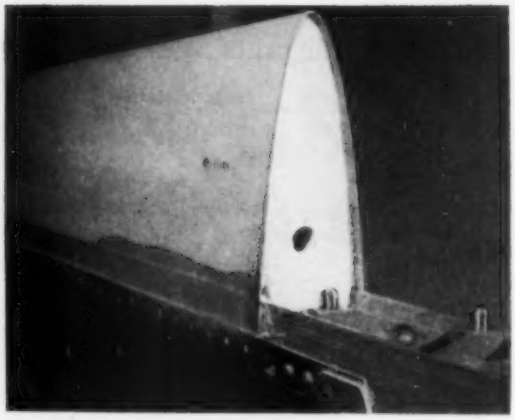
HARRY GERSTIN, Vice-president
American Latex Products Corp, Hawthorne, Calif.

HERE ARE THE TWO WAYS TO DESIGN

These were foamed in place



Magnesium fairing . . .
panel on Boeing KC-135 tanker aircraft has carefully tapered backing of polyurethane foam to damp destructive sympathetic vibration. Cast aluminum molds for this 10-ft-long structure are electrically heated for post-cure, cost $35,000. Molds are preheated 1 deg F per hr to 120 F, held there for 3 hr to cure foam, then cooled at 1 deg F per hr.



Leading edge . . .
on Radioplane lightweight target-drone wings forms cavity for rigid polyurethane core. Glass-reinforced plastic skin is adhesive-bonded to aluminum stiffener. Shear pins permit breakaway on rough landings—preventing wing damage. Precision jig, for holding skin in place while casting the core, cost $20,000.

Many designers look longingly at rigid and semi-rigid polyurethane foam—its high strength-weight ratio plus good resistance to high temperature, chemicals, and abrasion. But they hesitate to specify this plastic because of its past reputation for chemical instability during production. These problems have long since been solved; but another, more real barrier remains. It is the unusual scarcity of practical design information relating design, formulation, production, and end-use for these materials. Here is a down-to-earth approach to this interrelationship, intended to fill the gap and firm up designer confidence in the polyurethanes as engineering materials.

Most of these foams are cast in place as integral parts of an assembly, or as separate parts in re-usable molds. Foaming in place is more desirable because it eliminates further assembly labor. But cavity design is critical with either method—because the density, cell uniformity and size, and dimensional stability from any formulation can be affected by these factors: cavity shape, size, wall thickness and finish; its temperature at pouring; temperature and volume of polyurethane components, and the heat-cure cycle after the foam gels.

Designing the Cavity

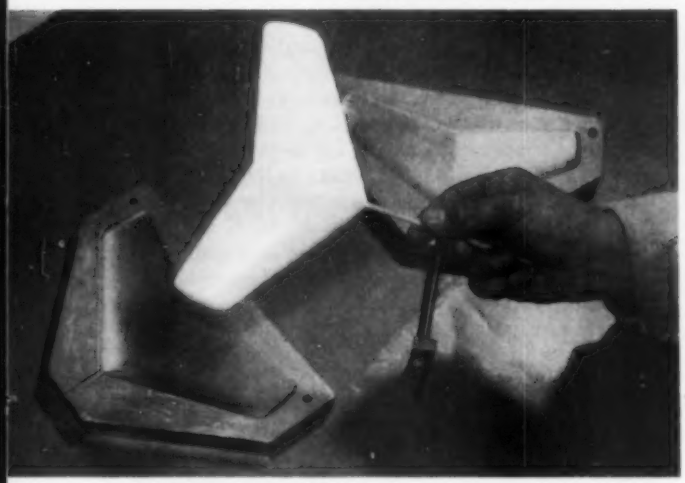
Cavity wall design hinges on the chemical and physical nature of the foaming process. Polyurethane components combine in a reaction that gives off heat. If walls are too thin, this heat dissipates too quickly. Foam cells at the wall then cool, collapse and gel prematurely—while the center foam continues to rise normally. Thus, irregular skin and surface voids appear. Solution is to pre-heat thin-walled molds, or use thicker walls. Occasionally special formulations are necessary. Permanent molds for cast parts are usually steel or aluminum; foamed-in-place assemblies use the same metals, as well as thermoplastic sheet and reinforced thermosetting resins. Wood and paper products are convenient for prototype cast parts.

Pressures up to 30 psi build up as carbon dioxide, the foaming agent, is generated and trapped in the viscous mix—thus complicating cavity wall design. Thin molds or skins will work unstiffened when the form is small or shallow, since these foam so quickly that heat transfer is no problem. But as size or closure increases, the cavity must be stiffened to retain tolerances. For cast parts, this stiffening is integral with the mold; for most foamed-in place cores, the skin is thin and must be held in shape with jigs. Properly stiffened molds or skin fixtures can cost from $25 for very simple small parts to $35,000 for large precision shapes—therefore are important in any polyurethane design.

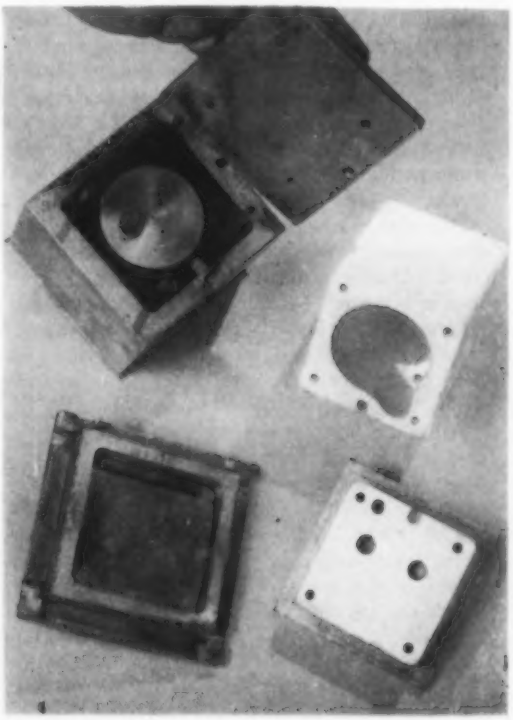
Foam density increases as the mold or cavity becomes

FOAMED POLYURETHANE PARTS

These were cast



Weathervane airfoil . . .
weighs 2 oz, is cast in a simple aluminum mold costing $150. Rigid polyurethane reproduces smooth mold surface, provides sufficient stiffness and abrasion resistance to take abuse in rugged climates.



Molded jacket . . .
around small missile pump-motor uses low thermal conductivity of polyurethane to keep heat away from delicate instruments nearby. It cost Wiancko Engineering Co $300 to devise the aluminum molds for jacket and cap. Molds have cores to provide holes and recesses.

Typical Polyurethane Properties
(all values at 75 F)

Nominal density, lb/cu ft	2	5	10	20
Compressive strength (at 50% deformation), psi	9	54	197	525
Compressive modulus, psi	170	1000	3100	8000
Compression set (after 50% deformation), %	10	35	42	40
Tensile strength, psi	18	58	155	300
Flexural strength, psi	10	85	275	650
Shear strength	7	28	78	175
Bond strength, psi				
to glass	9	25	50	142
to aluminum	10	27	56	158
to steel	12	29	62	146
to wood	17	29	62	170
Thermal conductivity, btu/ft²/hr/°F per in	0.21	0.22	0.24	0.29

more restricted—so, for uniform density, pressure should be equalized throughout the part. Bleed holes will do this. They should be placed at each high position or undercut to prevent gas entrapment. Size and placement of these holes is more critical than for metal casting, since the foaming gas as well as the air already in the cavity can cause voids or density variation. As the foam reaches the bleed holes, which can range from ⅛ in. to 2 in. dia, they should be closed off so that pressure equalizes in other sections.

Shrinkage in small simple parts is nil, and slight in large complicated structures of low density. Formulations at high densities tend to shrink more. For mass production, it is recommended that a mold for large parts be made slightly oversize, pilot parts formed, and the mold compensated by secondary cutting. With best technique, production parts have been held to ±0.005 in.

Adhesion to most surfaces is good, with bond strengths approaching tensile strength of the foam itself (see Table). Foamed-in-place cores therefore do not often require adhesives for bonding to the skin. For high-gloss metal skins, a special primer is recommended. Molds for cast parts, however, must be treated with a wax-type parting agent or lined with polyethylene or cellophane sheet. For a special surface on a cast part, the surfacing material can be sprayed or vacuum-formed on the mold before the polyurethane is poured. Auto dashboard crash pads, for example, are made this way with vinyl sheet for the outer skin.

Preheating the cavity is necessary to achieve rated strength for castings or rated strength and best bond for foamed-in-place parts. Uniform preheating to 100-130 F speeds the reaction and rise, minimizes skin effects, and helps the foam come to a uniform specified density. In addition, viscosity drops after the mix hits the warm walls, permitting a more rapid and even distribution within the cavity.

Foaming the Part

Choice of resin goes beyond the properties desired in the final part and forces the design engineer to help set up the production operation. Here, too, cavity size and shape are important: A low-viscosity slow-rising polyurethane is best for narrow complex cavities with few or small pour holes—to prevent voids; low-exotherm mixes are reserved for potting temperature-sensitive instruments or for structures with skins easily damaged by heat. High-exotherm polyurethanes are used for filling tall or large thin-walled structures that are hard to preheat. Here, the reaction is so rapid and violent that the foam is forced to all points before the walls can conduct the heat away. There are enough formulations available to meet these special production needs and still give the specified density and strength.

Mixing and foaming technique is as vital to good design as formulation selection, or design and preparation of the cavity. The key here is exact adherence to the process, once proper sequence has been fixed. Temperature, for example, can be critical: Some ingredients will "freeze" at 55-65 F and must be heated to liquify them before mixing. After mixing, the speed of most reactions doubles for each 20-F change in ambient. Thus, careful specification of mold and component temperature prevents premature foaming and non-uniform density. Blending time, too, is important: If incomplete, poor cell structure results; if too long, mix viscosity rises and impairs flow in the cavity.

The two components used in most rigid and semirigid polyurethanes can be mixed in a batch, or continuously for mass production. For either method, machine mixers have been developed that give good control over component proportions, temperature and blending. Ordinary mechanical blenders or hand-mixing will do for batch operation, but cell size becomes coarser and less uniform. In absence of a continuous-foaming machine, large cavities can be filled in multiple pours, since polyurethane bonds perfectly to itself. Maximum increment here is 8 lb, with 20-25 minutes between each pour. Density is usually not uniform—slightly lower at the top of each successive layer.

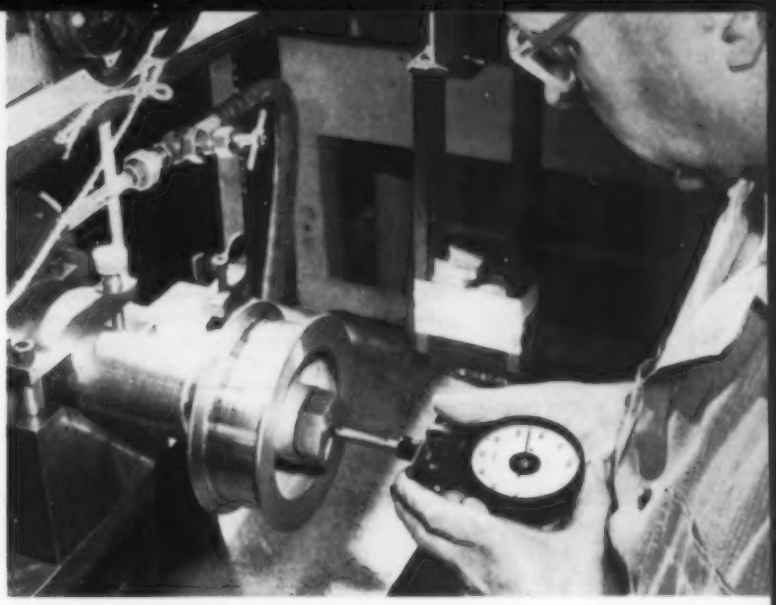
Post-foaming cure in an oven, by infrared radiation, or through heaters imbedded in the mold or jig, assists crosslinking of molecules and gives a fibrous type of foam with best properties. Room-temperature cure alone gives only 50-80% of maximum strength, leaving the foam brittle. Most common post-cure temperature is 225 F; for parts that will operate hot, 25-50 F above the top service temperature is best. The heat should be applied about 1 hr per in. of thickness in the direction of smallest dimension (but max cure time for any part is about 12 hr). Parts post-cured above 150 F should be cooled gradually—one degree per minute is a good figure—before removal from mold or jig. With foamed-in-place parts, this prevents delamination between core and skin. After the part is cooled, aging at room temperature for 72 hr before use brings strength to 90% of its ultimate value.

EDITOR'S NOTE: Other recent articles covering urethane rubber design include the following:

"Cast Urethane Rubber," Sept 16 '57, p 68. Latest data based on wide German experience in automotive applications.

"Sandwich-panel Core Materials," Jan 20 '58, p 70. Ready-reference chart compares urethane foams with 17 other materials.

"Plastics for Abrasion Resistance," Mar 31 '58, p 105. Table compares urethane rubber with six other elastomers.



Multi-range magnetic tachometer . . .
is a rugged, compact instrument valuable for quick checks and laboratory tests. Unlike the chronometric type, it measures instantaneous speed.

Rotational speed can be clocked with a variety of devices ranging from resonant reed or centrifugal weights to stroboscope and electronic counter. Here's your chart answering . . .

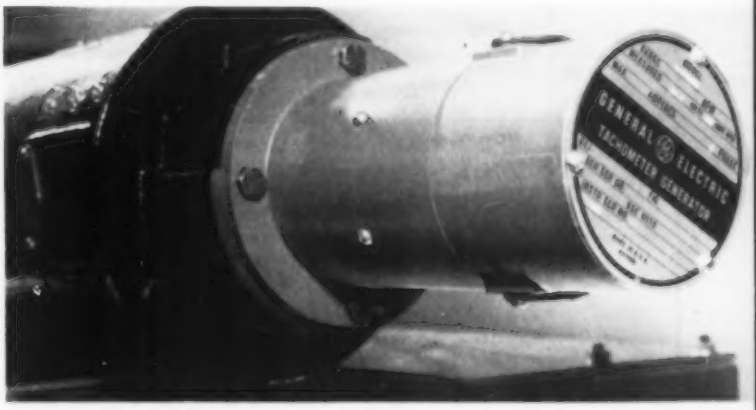
for measuring RPM— WHICH TACHOMETER?

H D DRAGE, *Test-equipment Specialist, General Electric Co.*

In 1785, James Watt didn't have the choice today's engineer has. To measure and control the rotational speed of his steam engine, he coupled a system of centrifugal weights to the engine shaft—the only method then available. The modern-day equivalent of Watt's mechanical tachometer is still in common use, but engineers today can choose from many other types—electronic or magnetic as well as mechanical (see chart on next page).

Choice depends on the machine whose speed is being measured, and the required accuracy. In some cases, tachometer readings are simply a laboratory measurement made to determine power output or to show that the machine is performing according to design specifications. In other ap-

(Text continued on page 92)



Permanently installed . . .
on the machine, generator tachometers give a signal that can drive a recorder or be fed back to control speed of the machine.

REPRINTED—circle E47, inside back cover

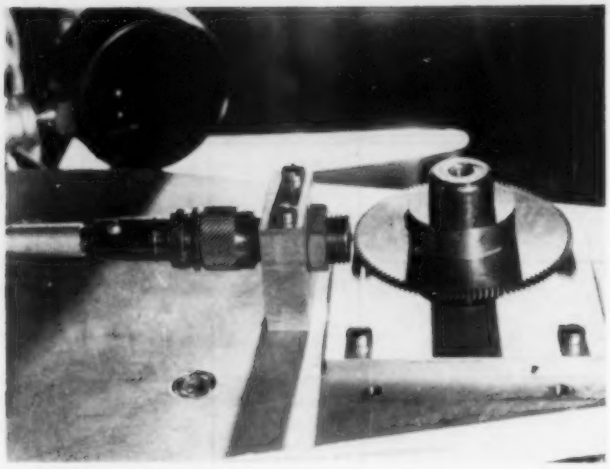
GUIDE TO CHOOSING THE RIGHT

	Type	Operating Principle	Range in rpm	Approx. Driving Torque
1	**RESONANT REED**	Consecutively tuned reeds, one of which is excited by vibration of unbalanced rotating parts.	900 to 100,000	None
2	**CHRONOMETRIC COUNTER**	Dial, geared directly to input shaft, reads in rpm; is started and stopped by accurate stopwatch.	0–100,000	Up to 0.4 oz-in.
3	**CENTRIFUGAL**	Dial is linked to mechanism measuring displacement of swinging centrifugal weights.	0–48,000	1.4 oz-in. on 300–4000 range; 0.6 oz-in. on 3000–40,000 range
4	**MAGNETIC DRAG**	Rotating magnet transmits torque to cup by eddy currents. Cup with indicating hand rotates against force of hairspring.	0–50,000	2 oz-in. on 0–200 range; 0.008 oz-in. on 0–50,000 range
5	**DC GENERATOR**	Generator with permanent-magnet field produces dc voltage proportional to speed. Measured with dc voltmeter calibrated in rpm.	0–5,000	1.5–54 oz-in. break-away torque
6	**AC GENERATOR** (voltage-responsive)	Generator with permanent-magnet field produces ac voltage proportional to speed. Ac is rectified and indicated on dc voltmeter.	0–80,000	1–9 oz-in. break-away torque
7	**SWITCHING CAPACITOR**	Switch, driven by shaft, switches polarity of fixed capacitor in series with battery and ammeter. Current flow increases with switching speed.	2–100,000	0.1 oz-in. on 2–1000 range: 0.03 oz-in. on 200–10,000 range
8	**AC GENERATOR** (frequency-responsive)	Generator with permanent-magnet field produces ac voltage whose frequency is proportional to speed. Rpm is indicated on frequency meter.	0–80,000	1–9 oz-in. break-away torque. Bearingless: less than 1 oz-in. driving torque.
9	**TONE WHEEL**	Gear teeth pass pole face of permanent magnet, cause flux changes sensed with pickup coil. Signal frequency measured as in (8).	0–6,000,000	Very small
10	**PHOTOCELL PICKUP**	Light, modulated by disk with holes, slots or reflecting surface. Chopped light picked up with photocell and frequency measured as in (8).	0–6,000,000	Negligible
11	**STROBOSCOPIC**	Variable-frequency pulse generator fires special neon lamp. Flashing light adjusted to "stop" motion and frequency is read from calibrated dial.	60–14,400	None
12	**ELECTRONIC COUNTER**	Improves accuracy of frequency-responsive devices 9, 10, 11. Counts voltage alternations over fixed time base.	0–6,000,000 with (9), (10), 500–5,000 with (11).	Depends on type of transducer

TACHOMETER FOR THE JOB

Obtainable Accuracy	Recorder Operation?	Hand-held or Mounted?	Advantages	Disadvantages	Comparable Cost (approx.)
About 2%	No	Both types available	No moving parts to wear out or require maintenance. Access unnecessary to rotating element.	For machines with only one rotating part. Well-balanced machines may not give definite reading.	$67 to $195
Up to 0.1%	No	Hand-held	Compact, portable. Quick readings can be made with good accuracy.	Gives only average speed over measured time interval. Needs reset after each reading.	$78 to $200
Up to 0.5%	Recording type available	Both types available	Rugged, compact. Shows variations in speed	Less accurate than chronometric type.	$90
Up to 0.5%	No	Both types available	Rugged, compact. shows variations in speed.	Less accurate than chronometric type.	$100
1% with calibrated indicator	Yes	Mounted	Signal easily fed back to control equipment or to operate recorders or function plotters. Very little drift.	Output signal sometimes has troublesome ripple difficult to filter. Unsuitable for high speeds.	$75 to $320 plus indicator
1% with calibrated indicator	Yes	Mounted	Signal can be fed back to control equipment or recorders. No brushes or commutation problems as with dc generators.	Speeds below 500 rpm require special 96-pole generator. Rectifiers cause long-time drift and nonlinearities.	$25 to $320 plus indicator
Up to 0.25%	Yes	Both types available	Can measure high speeds with good accuracy. Small driving torque required.	Hand-held model more bulky than (3) or (4).	$162 to $495
1% with ½% indicator	Yes	Mounted	Misalignment between rotor and stator doesn't affect frequency. Can mount bearingless model to utilize equipment bearings. Other advantages, same as (6).	Rectifiers cause drift and nonlinearities	$25 to $320 plus indicator
2%	Yes	Both types available	Will measure very high speeds.	Comparatively inaccurate and expensive.	$40 plus indicator
2%	Yes	Mounted	Does not load rotating member. Will measure very high speeds.	More complicated, more costly than tone wheel.	$200 plus indicator
±1% above 900 rpm	No	Hand-held	No contact with mechanism required and no power absorbed. Can also observe operation in slow motion.	Low accuracy. Limited speed range. Possibility of confusing multiples with true rotating speed.	$160
±1 rpm in 20–50,000 range with (9), (10). ±1 rpm in 500–5,000 range with (11).	In digital form	Depends on companion device	High accuracy. Digital readout. If time base is properly chosen, reads directly in rpm.	Expensive. Other disadvantages depend on type of transducer.	$475 to $1675

Flashing light . . .
of stroboscope measures rpm without contacting or taking power from the machinery. Here, operator adjusts frequency of flashes to "stop" motion of fan.



Gear teeth tell speed . . .
as they whir past pole piece of the magnetic pickup. Signal frequency is measured on meter calibrated in rpm.

For extra accuracy . . .
a digital electronic counter counts pulses from a hand-held version of the magnetic tone wheel and shows total in five lighted window slots.

plications, rotational speed must be constantly monitored by the operator, so a tachometer is included as part of the machine or readings are fed to a control system that maintains constant rpm.

The newer electronic tachometers allow measurements at high speed and with an accuracy, in some cases, of ±1 rpm. Key to such accuracy is a digital electronic counter which counts fluctuations in signal voltage. An electronic counter can increase accuracy of any speed-sensing device whose output frequency is proportional to shaft rpm. Connected to such a unit, it will count voltage cycles over a given period of time and display total in a series of lighted readout digits. Counter will read directly in rpm if counting time is chosen to correspond with type of sensing unit.

But such accuracy is not always necessary. Less-accurate tachometers are often more rugged or better suited to permanent mounting on the machine. The automobile speedometer, for example, is essentially a tachometer measuring drive shaft rpm and calibrated in mph. It is usually the magnetic drag type. Revolution counters for aircraft and marine engines are often the centrifugal type. Tachometer generators and switching capacitors, on the other hand, are frequently used when a control signal is fed back to keep output rpm constant.

The chart accompanying this article does not list all possible methods of rotational speed measurement. Other principles of operation and other sensing devices have been used successfully in some special applications. The chart lists only the most popular types.

REPRINT of this article can be obtained for your reference file by checking No. E47 on one of the Reader Service cards bound in this issue. For other reprints available, see "Current Reprints" listing in this issue on page 169.

EDITOR'S NOTE—Various tachometers and how they work are briefly described in "12 Ways of Measuring Speed," Feb '57, p 192. Operating principles, applications and advantages of the switching-capacitor type are detailed in "Capacitor Commutator Tachometers," Mid-Oct '55, p 1 28.

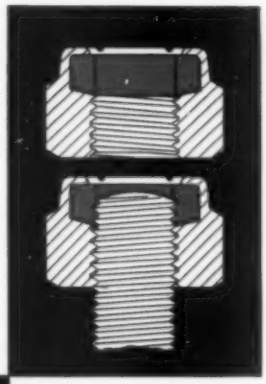
What's special about this STOP NUT?

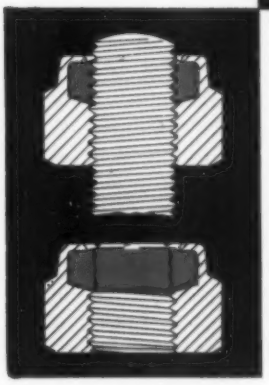
Several things make this nut unusual. For instance, you can "stop" it at any position on the threaded length of the bolt . . . or wrench it tight against the work where it protects bolt threads against corrosion and prevents liquid leakage. No matter where you leave it on the bolt, it will remain tight in that exact position, even though you subject it to heavy vibration and shock loads. But use a wrench on it and it comes off as easily as it went on. The red locking collar is nondestructive—does not gall bolt threads or remove plating. You can remove it and re-use it again and again.

What gives it its grip?

1 The locking collar is unthreaded and elastic. It has an inside diameter smaller than the major diameter of standard bolts.

2 The bolt impresses a mating thread into the collar and the resulting compressive forces exert a constant friction grip on the bolt. . . .





3 and exert a downward thrust bringing the lower flanks of the bolt thread into firm metal to metal contact with the matching nut threads, eliminating normal axial play.

4 Nut is removable and reusable . . . the Red Elastic Collar retains its grip after repeated usage.

Will it hold under ALL conditions?

The locking principle of the Elastic Stop® nut has been tested and proved by over 25 years of actual field service. Elastic Stop nuts are used on locomotives . . . and pile drivers. They fasten hedge shears and harvesters, drilling rigs and washing machines, trucks and roller skates. And no Elastic Stop nut customer has ever stopped using them because of unsatisfactory performance.

What about sizes and materials?

Elastic Stop nuts are available from a watchmaker's 0-80 all the way to 4"—in materials that include stainless steel, brass, aluminum and other alloys. Protect your product with "fastener insurance." Try Elastic Stop nuts on trouble spots, whether to protect expensive heavy equipment from costly downtime or to guarantee the accuracy of delicate electrical equipment by maintaining precision adjustments. We'll supply free test samples.

ESNA®
TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N82-112, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____

foreign digest:

PACKED GLANDS for HIGH

Here are tips on packings and gland design to help answer sealing problems. Spacers, leak-off points and radial sealing will be covered in a coming issue.

From England

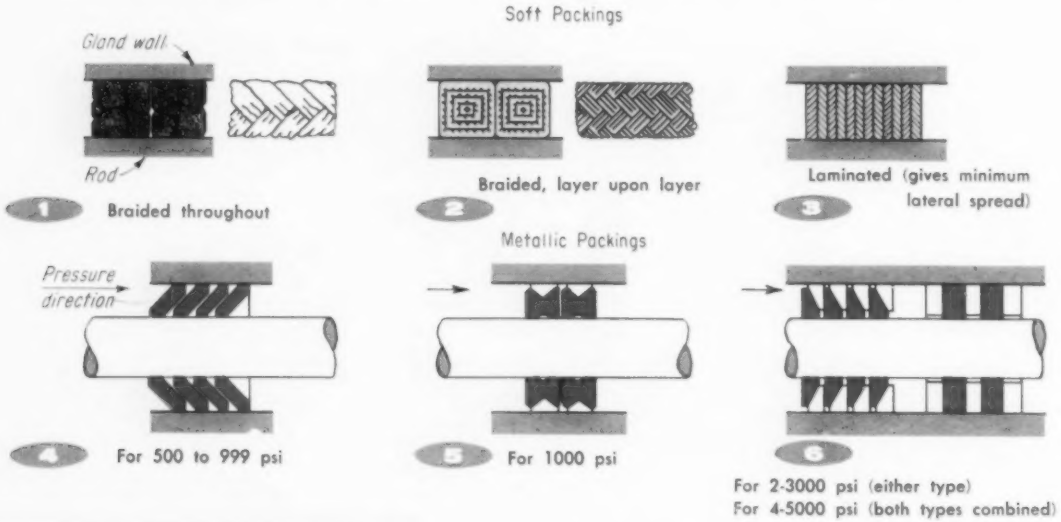
These are highlights from "Packed Glands for High Pressures: An Analysis of Fundamentals," by Professor J. L. Thomson, Dept of Civil and Mechanical Engineering, Royal Military College of Science, Shrivenham, Swindon, Wilts; published by the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London SW 1.

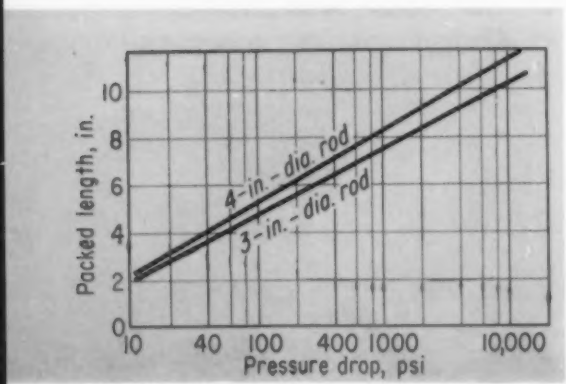
The correct function of a sealing gland is to maintain fluid pressure rather than try to prevent all leakage. In most cases where there is relative motion between surfaces, zero leakage can only be had at the price of high friction, overheating, wear and excessive maintenance. A small amount of leakage is rarely troublesome and simplifies high-pressure sealing problems. If necessary, the gland can be fitted with a leak-off outlet to conduct leakage back to the system.

High pressures tend to squeeze the packing between the gland walls, thereby helping sealing action. Ideally, packing for higher pressures should be rigid enough to resist increased crushing forces, yet flexible enough to give good sealing. If too stiff, packing cannot conform to variations in alignment; soft packings, though more adaptable, are frequently the cause of excessive rod wear when used as high-pressure packing. The aim should be to secure, by controlled deformation of the packing, just enough conformability at the working pressure—giving max sealing with min wear.

PACKINGS FOR HIGH PRESSURE

Gland packings illustrated in Figs. 1 through 6 are numbered in ascending order of suitability.





BASICS OF DESIGN

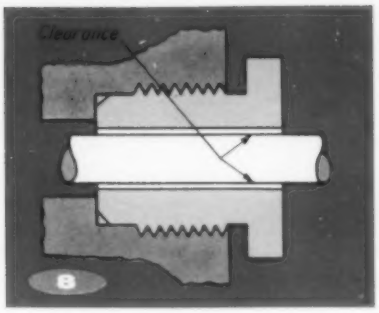
(Figs. 7 through 11)

7

Gland length . . .

is shown here in a logarithmic plot. Solving a gland problem is more than selecting the correct packing—rigidity and alignment of the whole machine becomes so important at pressures over 5000 psi that the entire machine should be "designed around" the gland.

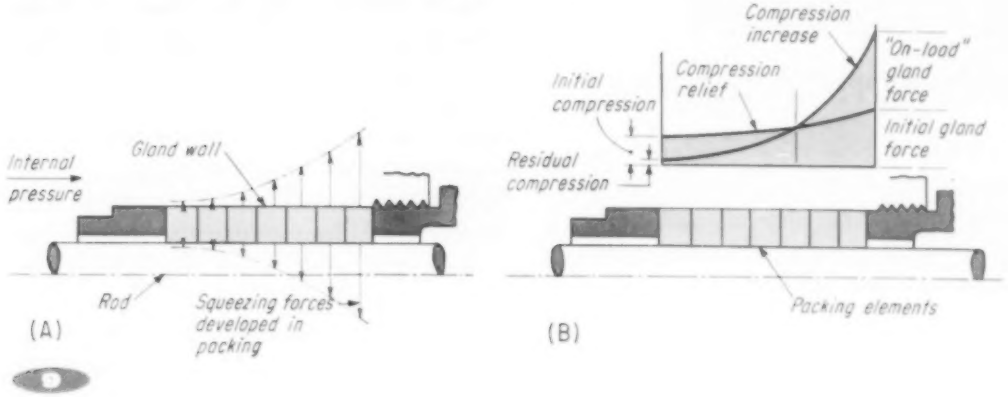
PRESSURE

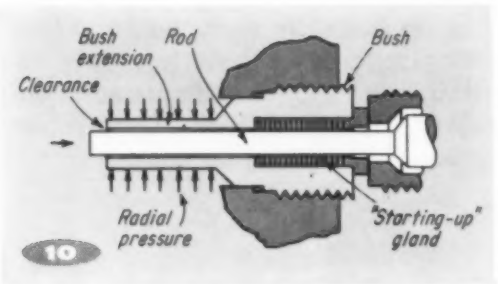


Simple clearance . . .

gland (8) would control leakage by keeping space between gland walls and rod small enough to restrict fluid flow, which varies with viscosity. In practice, however, production tolerances usually cannot give a small enough clearance. Packing, therefore, helps overcome this problem by taking up the clearance. Except at low pressure, the initial force exerted on the packing does not bring about sealing action.

Each packing element (9A) constitutes an annular piston across which there is a pressure difference. Each element supports the next one and the forces on it. Squeezed by the axial force, the packing spreads laterally, thereby exerting force changes (9B) when the internal pressure acts on the packing. The pressure tends to relieve compression at the start of the gland and increase compression at the end.





Special-type . . .

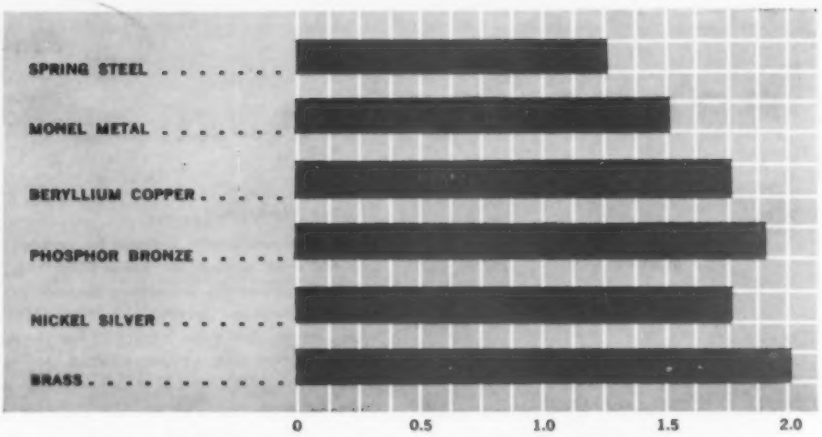
clearance gland is necessary when really low friction forces are essential. At high pressures, a plain bushing, as in simple clearance glands, would dilate and cause increased clearance. Extended bushing counteracts this. Radial pressure on the extended part squeezes it so that correct clearance is held. Careful selection of dimensions and elastic properties of the bushing material gives clearance control at working pressures. "Starting-up" gland provides a seal until sufficient pressure is built up to act on the bushing extension.

Friction in Packed Stuffing Boxes

Pressure drop, psi	20	50	100	500	1000	5000
Initial tightening, psi	6.68	12.8	21.8	90.5	145	588
Initial tightening, total axial force, lb	74.6	143	246	1000	1600	6500
Full pressure force *P*, lb	224	560	1120	5600	11,200	54,000
Friction force, (caused by tightening), lb	225	493	810	Considered not applicable		
$A\mu$, where *A* is packing factor, μ is friction coefficient	0.30	0.20	0.14	0.053	.044	0.032

11

Initial tightening forces are given in table at left for various pressure drops—for a gland with 0.75-in.-square packing and a 4-in.-dia. rod. Up to 100 psi the friction force caused by initial tightening is almost equal to the full pressure force—sealing depends entirely on initial tightening. Above 100 psi, however, initial tightening forces become less and less significant as the pressure drop increases—sealing depends mainly on internal pressure.



PER CENT DECREASE IN STIFFNESS WITH 100°F. INCREASE IN TEMPERATURE

How Temperature affects spring stiffness

When service or operating temperatures are above room temperature, spring selection must take into consideration several factors usually of little consequence in ordinary service.

These are loss of strength, thermal expansion, deflection, drift and hysteresis.

The first effect — loss of strength — is usually the most serious. What happens is that the safe stress carrying capacity of the spring material decreases at higher service temperatures and springs of ample strength at room temperature may be too highly stressed when heated.

These effects may be small in many cases, but under some conditions they may be important, particularly when temperatures vary over a wide range. Where an accurately determined spring strength at elevated temperature is desired, the specifications covering load test at room temperature should be corrected for the change that will occur. The approximate amount of correction for 100° F change in temperature for various materials is shown in the chart above.

With today's increasing high-temperature problems in many fields, proper spring selection is more than ever important. The subject is discussed in our latest pamphlet, "High Temperature Springs." Write for your copy.

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
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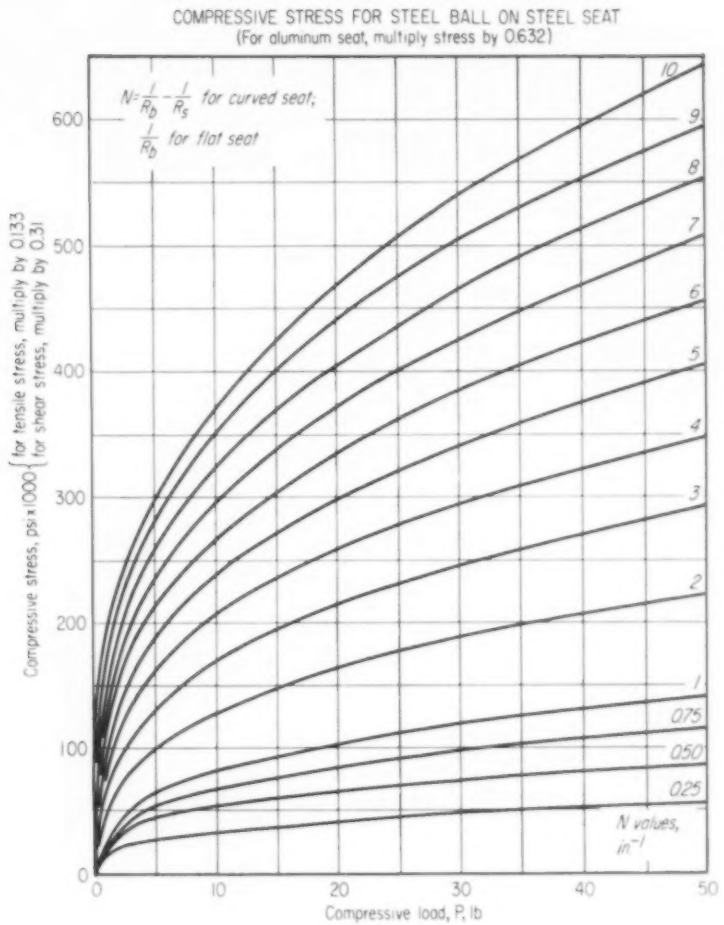
5811

REFERENCE BOOK SHEET

How much STRESS on a BEARING BALL?

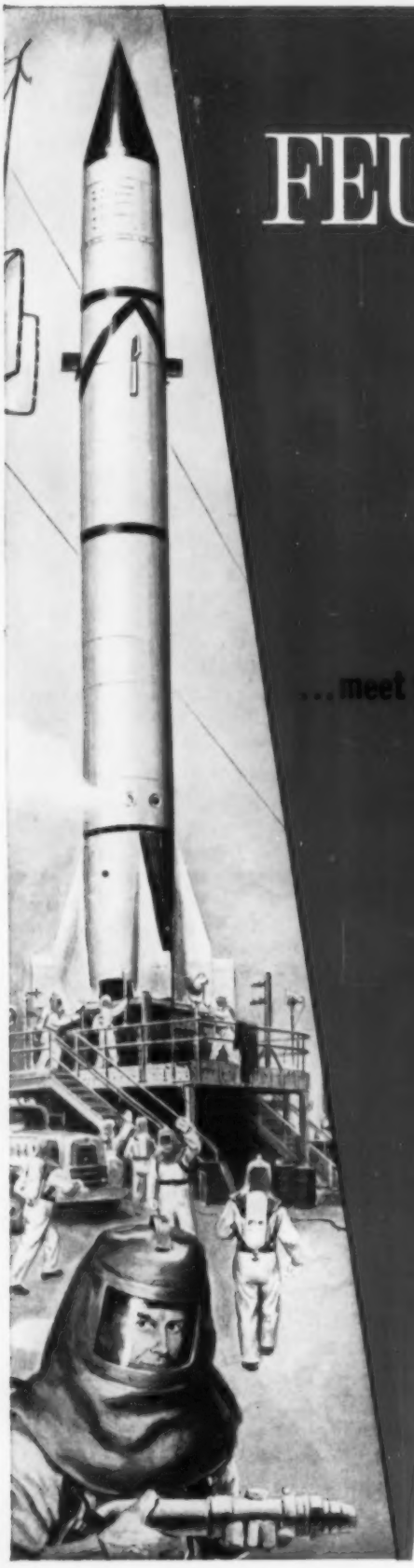
These curves indicate permissible loads when seat is spherical or flat, steel or aluminum.

JEROME E RUZICKA, *Staff Engineer, Barry Controls Inc, Watertown, Mass.*



When a design uses steel bearing balls to support a load, it is important to know what stresses result. They are charted on this page. On the continuing page is a diagram that identifies symbols—for applications where the seat is spherical or flat—and also a chart that will help calculate maximum permissible loads.

(Continued on page 99)



SYNTHETIC – FIBER

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...meet the DESIGN CHALLENGES of the Space Age!

Exclusive Thermal and Chemical Properties Are Combined in These Newest of Engineering Materials

NOW – Conquer your most exacting design problems with this *completely new* class of materials!

Feutron Felts are mechanically interlocked, synthetic fiber, engineering materials . . . perfected after years of research by American Felt Company.

Durably fabricated from selected man-made fibers – Rayon, Nylon, Dacron,[1] Orlon,[2] Dynel,[3] Arnel,[4] Acrilan[5] – they provide *all* the valuable operating properties of these synthetics . . . high tensile strength; superior resistance to acids, alkali, solvents and other chemicals or gases; dimensional stability; three-dimensional physical properties *plus* the ability to operate at temperatures up to 400°F!

You'll find Feutron Felts are being used for wet and dry filtration, as high temperature oil seals, as reinforcements for plastics, as rugged gaskets, as lubrication wicks, as thermal and acoustical insulation and in hundreds of other vital applications.

Where could you be using Feutron Felts to improve product performance? Get all the facts . . . write today, for Feutron Data Sheet, on company letterhead please.

Remember: American Felt Company has the most extensive and best equipped staff of product engineers in the Felt industry . . . ready to help you select the most efficient wool or synthetic fiber Felt for your application.

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American Felt Company
TRADE MARK

1. Du Pont polyester fiber trademark.
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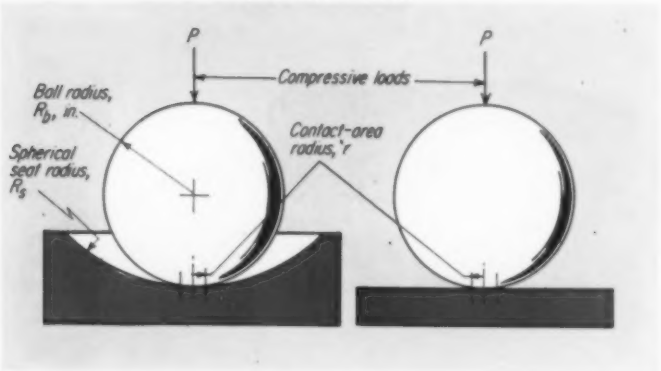
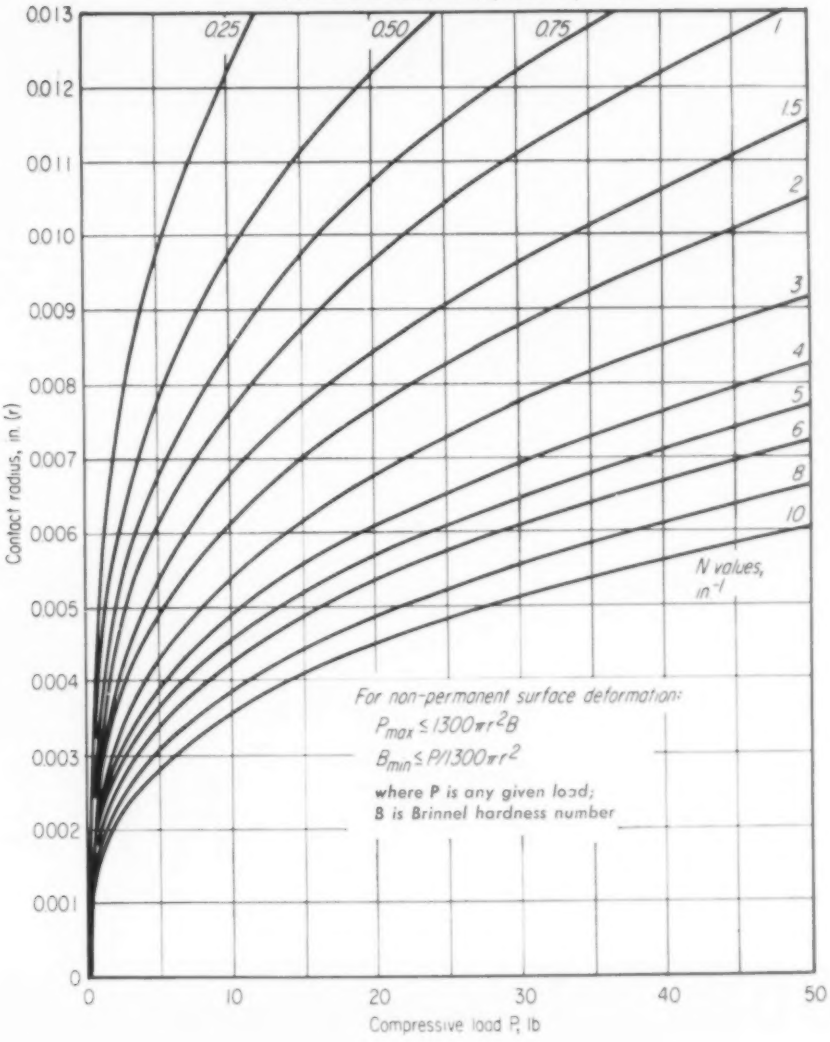
3. Carbide & Carbon Chemicals Co. acrylic fiber trademark.
4. Celanese Corp. triacetate fiber trademark.
5. Chemstrand Corp. acrylic fiber trademark.

How much stress on a BEARING BALL? (cont)

Symbols used with curves



CONTACT RADIUS FOR STEEL BALL ON STEEL SEAT
(For aluminum seat, multiply radius by 1.25)



B.F.Goodrich

Lawn Boy cuts cost of fuel tank assembly with B. F. Goodrich Rivnuts®

When Lawn Boy designed their current power mower models, they decided to *suspend* the fuel tank underneath the streamlined shroud. But in order to do this they needed specialized fasteners that would fit inside the tank and provide shock-proof, fuel-tight nutplates.

They found that B. F. Goodrich Rivnuts would do this job better and more economically than any other fastener. Here's how. After the tank is formed, two holes are punched in its top. One man takes only a few seconds to upset Rivnuts in these holes. Screws are then inserted through the shroud and into the Rivnuts, attaching the tank solidly.

B.F.Goodrich Rivnuts provide firm nutplates that won't vibrate loose during operation of the mower. In addition, the special closed ends and tight clinching action of Rivnuts form a 100% fuel-tight seal.

Rivnuts can be used hundreds of ways to simplify production—give your products more eye-appeal, more sales-appeal! If you haven't already investigated their potential in your own business, why not do it now?

Send today for free Rivnut Demonstrator

Demonstrates with motion how you can use Rivnuts to fasten TO and WITH. Explains construction, simplicity of installation. Get your free copy today by writing to: *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-118, Akron, Ohio.*

B.F.Goodrich ***aviation products***

SIGNIFICANT COMPONENTS • MATERIALS • PROCESSES

Imbedded printed circuits . . .

are locked-in-place and will not lift, peel or separate from encapsulating material even under severe conditions. Conductors are three to six times thicker than surface-type circuitry and lines may be made narrower and placed closer together to permit miniaturization without sacrificing operational or mechanical quality. Only terminals and/or contact areas are exposed, insulating against moisture, corrosion and contamination. Imbedding process is said to conform with government recommendations for reliable circuitry. Replacement of components after circuit is in use is accomplished without damage to circuit or its components. Process is patented. **Beck's Inc, 300 E 5th St, St Paul 1.**

Circle 1, Reader Service Card

Hard, flexible vinyl fiinish . . .

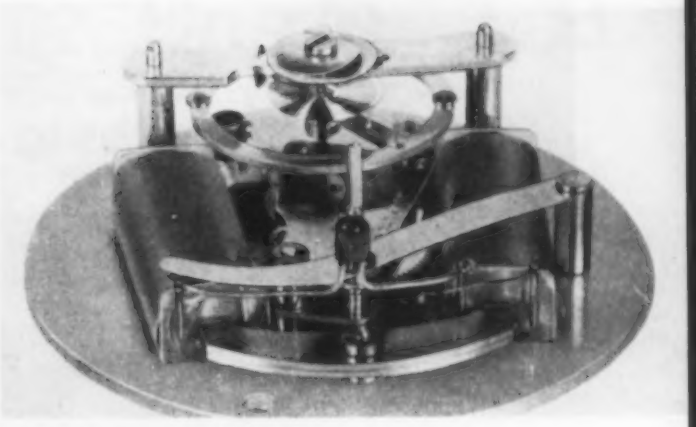
is said to be up to five times more resistant to abrasion than most textured alkyd urea enamels and highly resistant to corrosives. Unlimited variety of colors, with various degrees of sheen, is offered in pebble texture or smooth finish. Said to withstand perspiration, ink, beverages, commercial cleaning preparations, as well as many other acid or alkaline corrosives. Especially suitable as coating for parts made of glass fiber-reinforced polyester resin and phenolic moldings since baking temperatures are lower than those required for vinyl plastisols and organosols. Can be sprayed with standard paint equipment or electrostatic processes. Textured finish also masks imperfections in metal surfaces. Priced competitively with standard alkyd urea enamels. Packaged in 5-gal. and 55-gal. containers. **Metal & Thermit Corp, Rahway, NJ.**

Circle 2, Reader Service Card

Extruded polyethylene plate . . .

in continuous unlimited lengths is available in thicknesses to 1½ in. and widths to 48 in. Chemically inert to many materials, including concentrated hydrochloric, sulfuric and hydrofluoric acids. At room temperature, tensile strength is 1700 psi; stiffness is 13,000 psi. Prices range from 60¢ to $1.25 per lb, depending on quantity, type and thickness. **Micarta Div, Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30.**

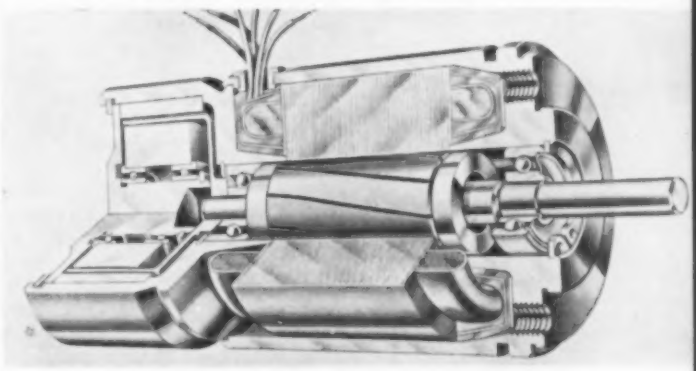
Circle 3, Reader Service Card



Integrally powered timer . . .

for dc voltage from 1.5 to 12 v has movement that is 2.4 in. dia x 0.75 in., excluding dial train and setting stem. C-size, 1.5-v cell permits 2-yr operation, over wide range of environmental conditions. Movement is said to operate for 20,000 hr. Accuracy is reported to be 0.01% at normal temperatures; 0.02% in temperatures from 10 to 110 F and 10% voltage variation. Basic timer is available in clear plastic housing or dustproof movement enclosure for use with isolated battery source. $10.50 to $15 for movement with 5-sec-per-day regulation, depending on quantity, packaging and application. 60 to 90-day delivery for production quantities. **Hamilton Watch Co, Allied Products Industrial Div, Lancaster, Penna.**

Circle 4, Reader Service Card



Subminiature servomotor . . .

for acceleration and deceleration damping without loss in steady-state velocity, where overshoot can be tolerated to achieve fast response. Damping results from viscous friction induced by magnetic coupling of low-inertia drag cup to freely rotating magnet flywheel. No-load speed is 6000 rpm. Stainless steel case, shaft and bearing and encapsulated windings. Withstands shocks loads to 100 g and vibrations of 30 g to 2000 cps in all major axes. Ambient-temperature range is from —67 to 266 F. Power input is 2.6 w per phase. The 1.355-in.-long size-8 servomotor weighs 2 oz. Available within 30 days of order. Price depends on specs. **Helipot Div, Beckman Instruments Inc, Fullerton, Calif.**

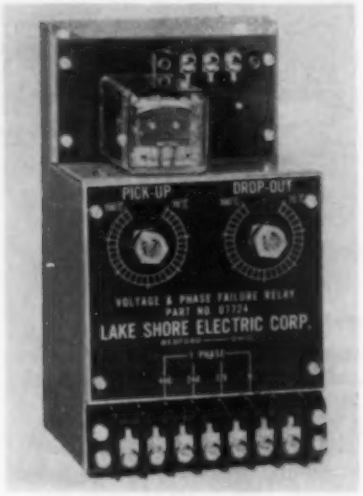
Circle 5, Reader Service Card

. . . CONTINUED ON PAGE 102

Subminiature switch . . .

detects gas leakage in closed volumes where normal gas pressure varies with temperature; detects and signals when gas densities subject to wide variations in temperature approach a critical value. Model RM-73 actuates along, or parallel to, a temperature-pressure line of 0.0275 psia/° Ranking or 0.00256 lb-mols per cu ft. Weighs 2 oz. Meets applicable military environmental specs and withstands 20-g shock, 5 to 1000 cps at 10 g vibration in temperatures of —85 to 200 F. Electrical rating is 28 v dc, 110 v ac, 5 amp, SPST or SPDT. Accuracy of actuation point is said to be 0.8 psi over temperature range. Difference between actuating and deactuating pressure is 2 psi. **Newark Controls Co, 15 Ward St, Bloomfield, NJ.**

Circle 6, Reader Service Card



Voltage-sensing relay . . .

uses a printed circuit with standard plug-in SPDT relay to open and close circuits. Unit is said to control range of 70 to 100% of rated voltage for dropout and pickup with a min 1-v differential, by using calibrated variable potentiometers. For 6 to 49 and 50 to 250-v dc service; single and 3-phase, 3 and 4-wire ac service. Standard ac relays are available in open models or with NEMA-2 enclosures. Unit protects industrial motors, machine tools and electronic equipment. **Lake Shore Electric Corp, 205 Willis St, Bedford, Ohio.**

Circle 7, Reader Service Card

Solenoid valves . . .

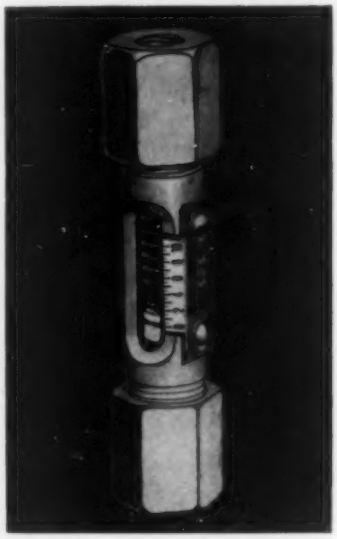
in two series are for air, oil, cold and hot water, and gas service in ambient temperatures of —20 to 200 F and media of —20 to 175 F. Low-amp coils, offered for all common ac and dc voltages and frequencies, are rated for continuous duty and have splashproof, nickel-plated housing. Valves operate in any position. Base has two ¼-in. mounting holes. Series A, in ⅛ and ¼-in. pipe sizes, includes 2-way, 3-way and directional types, normally closed or normally open. Available with stainless steel body or brass body with stainless steel seat-insert and grommet or conduit electrical outlets. Series B, a midget, 2-way, normally closed valve, has ⅛-in. NPT ports, brass body, stainless steel seat-insert and grommet electrical outlet. Both series operate at up to 600 cpm and are said to have a life of over 30 million cycles. **C A Norgren Co, 3400 S Elati St, Englewood, Colo.**

Circle 8, Reader Service Card

Silicone rubber parts . . .

developed for specific applications and facilities for molding them to tolerances as close as 0.002 in. on a thickness of 0.007 in. are formulated for extreme conditions, including resistance to fuels, oils, solvents, moisture, ozone and weathering. Long shelf life without deterioration and flexibility in temperatures from —130 to 500 F are characteristic. **Sierra Engineering Co, 123 E Montecito, Sierra Madre, Calif.**

Circle 9, Reader Service Card



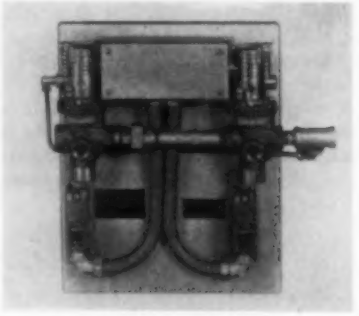
Miniature flowmeter . . .

indicates if fluid flow is taking place and meters quantity. Rate of flow is measured by variable-position orifice, visible in glass-sealed opening, adjacent to scale, which is calibrated in units of 1 to 10. Flow rate is set by hand valve. Suitable for pressures to 100 psi max. Available in capacity ranges from ¼ gpm at low end of the low range to 4 gpm max at high end of high range. Can be inserted into ¼-in. IPS pipe line. **Henry G Dietz Co Inc, 12-16 Astoria Blvd, Long Island City 2, NY.**

Circle 10, Reader Service Card

Fail-safe control system . . .

has dual interlocked, but independent, pneumatic - electrical - mechanical circuits said to prevent accidental repeat operation on single cycling machines. Failure of any one (or more) component automatically stops the machine, at once or at end of cycle. Also prevents start of next cycle until fault is corrected. Built to JIC or specified standards, system consists of



. . . CONTINUED ON PAGE 104

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

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METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

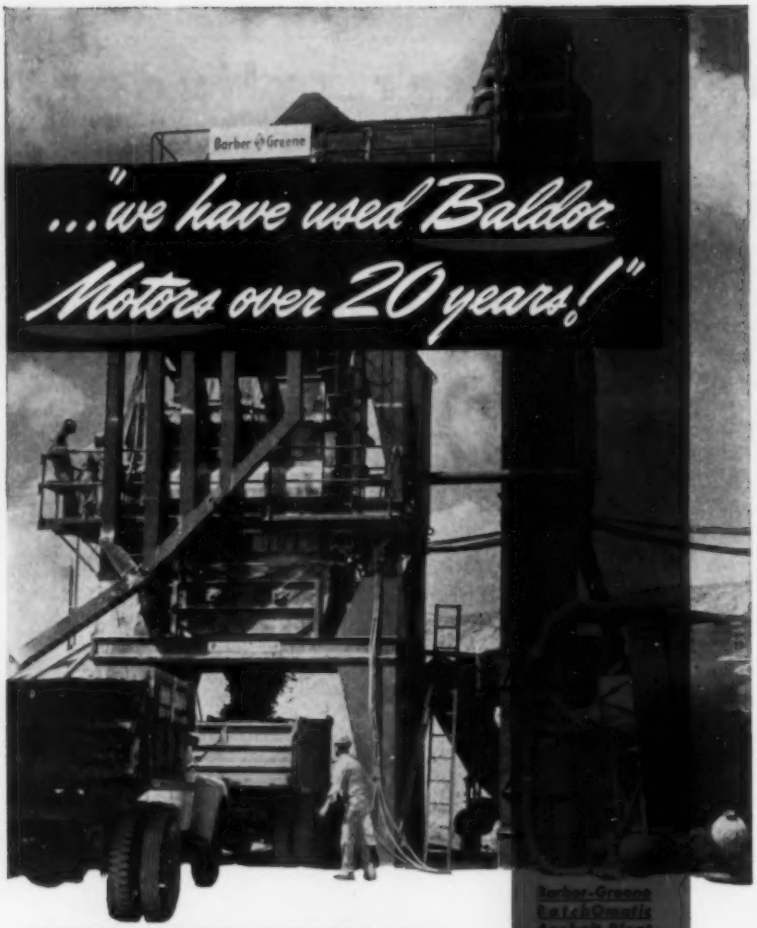
NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

CIRCLE 158 READER SERVICE CARD



Barber-Greene Batch-Omatic Asphalt Plant

Up to 6 Baldor Streamcooled Motors are used to power these gigantic machines

BARBER-GREENE Depends on Baldor Streamcooled Motors to Power Its Asphalt Batch Plants & Belt Conveyors!

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This kind of superior performance has earned Baldor an enviable reputation among many outstanding heavy equipment manufacturers.

If you have a power problem that demands the utmost in motor performance, perhaps Baldor can help you, too!

Find out why you get *more* with Baldor —write for FREE color catalog!

BALDOR ELECTRIC COMPANY

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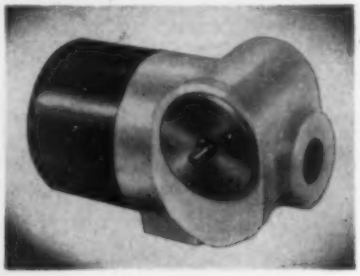
prewired valve package and prewired control panel assembly, plus limit and "run" pushbutton switches. Uses standard relays and limit switches, with modified standard air valves. Circuits are number-coded with accessible terminal strips. **Textrol Inc, 4015 Prospect Ave, Cleveland 15.**

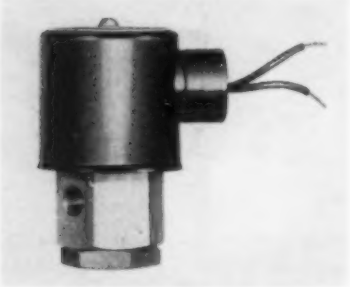
Circle 11, Reader Service Card



FHP motors . . .

in a dozen or more models of 1/1000 to ¼-hp capacity include universal, dc, ac and permanent magnet–induction, gear, governor and brake types. Sizes range from 1¼ in. dia x 2½ in. long. Weight, 7 oz. Illustrated is an ac or dc reversible gearmotor rated 1/350 hp max, 100 to 300 rpm. For continuous-duty operation on 6 to 48 v. Weighs 12 oz. **Carter Motor Co, 2773A W George St, Chicago.**

Circle 12, Reader Service Card



Direct-lift valve . . .

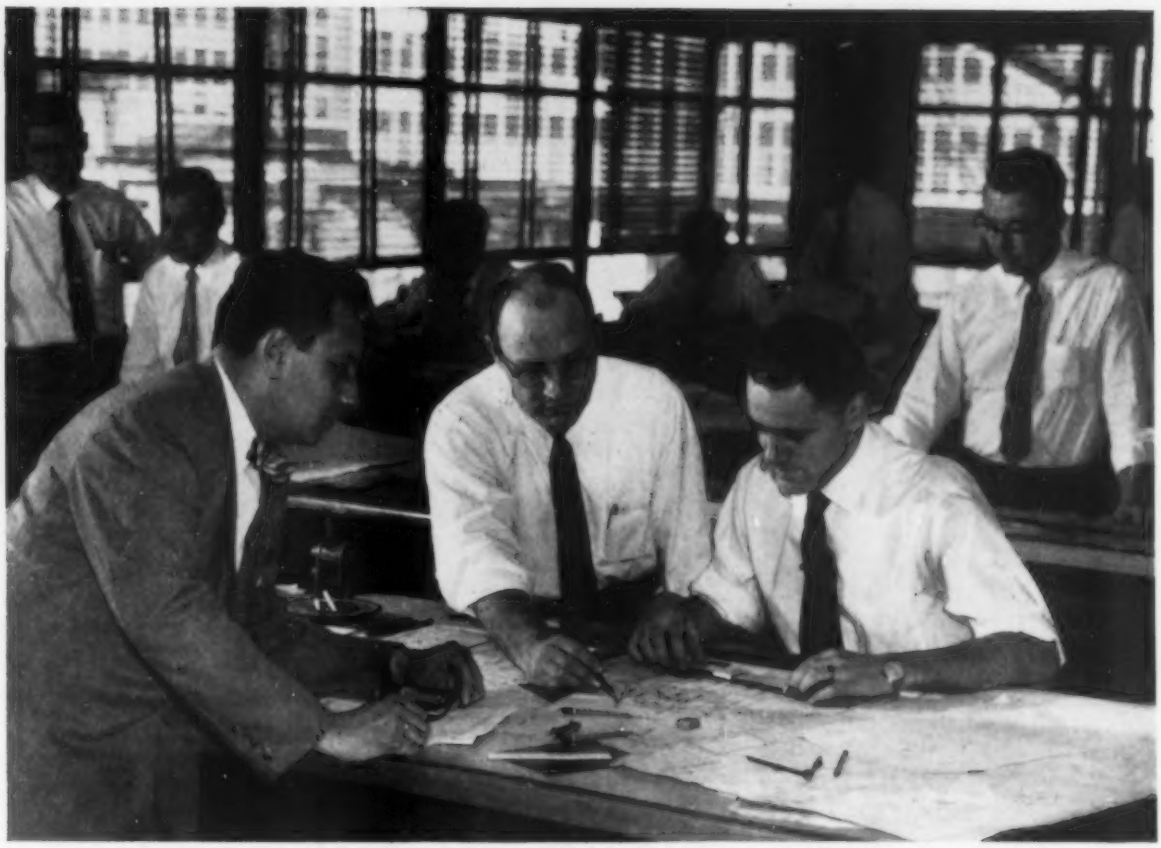
is solenoid-actuated. May be used for air, gases, water, oil, steam and other media not harmful to brass, from which single-seated, angle-type valve is machined. For 0 to 400 psi and pipe sizes of ⅛ and ¼ in. Valve is 3½ in. high. Suitable for applications where a wide range of pressures is coupled with relatively little flow. **Atkomatic Valve Co Inc, 545 W Abbott St, Indianapolis 25.**

Circle 13, Reader Service Card

Oil-free piston air pump . . .

is applicable with temperature, humidity, damper or pneumatic controls or systems. 9 x 5 x 8-in. unit weighs about 10½ lb.

(Continued on page 108)



Engineers at world-famous M. W. Kellogg Co. find the detail on these 8-year-old Kodagraph Autopositive Paper intermediates easy to read. Same goes for the white prints made from them.

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...these answers to your control "puzzles"

L **NEW two-way valve for high flow industrial applications**

At greatly reduced cost, this larger pilot-operated valve permits applications not possible before. Designed for air, oil, water. Features ½" orifice with ⅜" or ½" NPT ports, ¾" orifice with ¾" NPT ports, 1" orifice with 1" NPT ports. Pressure differentials: 5-150 psi. Body is naval forged brass. Diaphragm is fully supported. Available in standard and Explosionproof construction, normally open or normally closed.

A **NEW three-way valve for medium-sized cylinders**

Available normally open, normally closed, directional control and multi-directional, with 3/32" inlet and 5/32" exhaust orifices and ¼" NPT ports. Designed to control air, oil and inert gases. Handles pressures to 125 psi. Body is non-corrosive zinc. Internal parts are stainless steel.

LC **NEW two-way, low-cost, pilot-operated valve**

A smaller, lighter, normally closed valve. Permits full flow through ½" orifice with ⅜" or ½" NPT ports. Will control all common media: air, oil, water, etc. Pressure differentials: 5-150 psi. Forged naval brass body. Uniquely designed diaphragm – fully supported.

R **NEW two-way valve for standard and high pressure applications**

A big capacity, pilot-operated valve with a ¼" orifice and ¼" NPT ports. Designed to control air, water, oil, semi-corrosive materials. Long-lasting, stainless steel internal parts. Forged naval brass body. Available normally open or normally closed. Standard models operate on pressure differentials of 5-200 psi; high pressure normally closed models on 5-1250 psi.

For complete information, please contact our Representative or Distributor near you . . . you'll find him listed in the yellow pages or write us at the address below, Department 45N.

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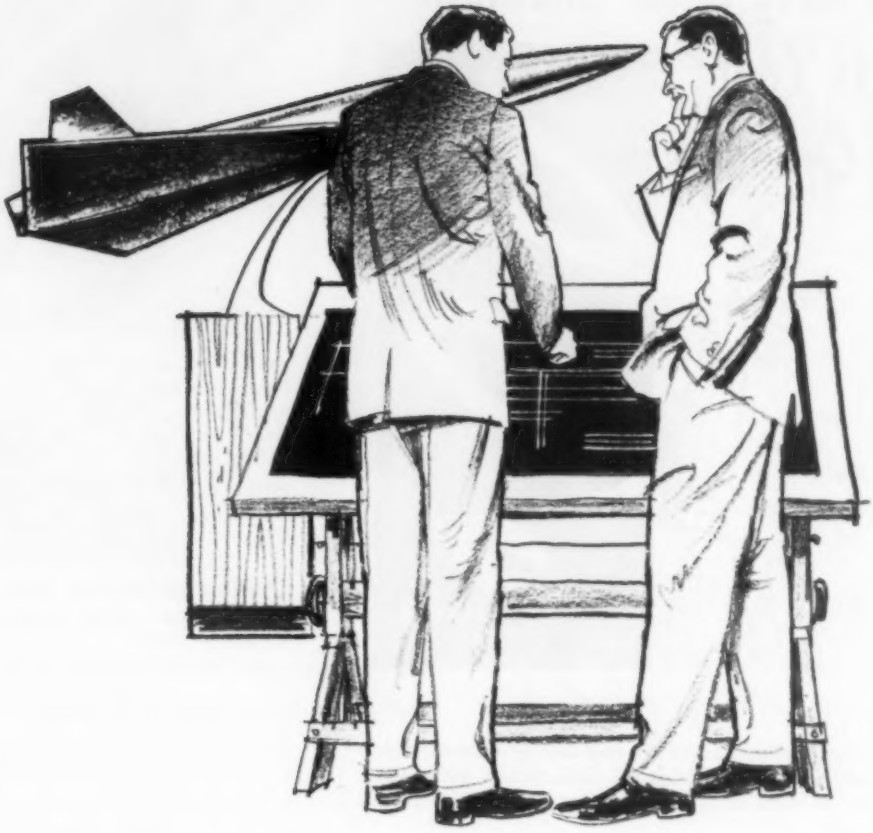
SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE



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Why Use Less Than Chemlon* Packings In Your Hydraulic Cylinders

Hydraulic equipment manufacturers are now taking a *second* look at the many advantages of "John Crane" CHEMLON hydraulic packings and offering them in place of leather, fabric-reinforced and similar packings.

THE REASON . . . CHEMLON provides several very important service advantages.

1. Increased cylinder life due to the inherent non-frictional qualities of CHEMLON.
2. Longer packing service life—CHEMLON outlasts all other types of packing to a remarkable degree . . . decidedly cuts replacement, down time and maintenance.
3. Universal application—CHEMLON'S inertness to all types of hydraulic fluids, including non-flammables and synthetics . . . eliminates the need for customers stocking a wide range of special packings.
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Crane Packing Co., 6445 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

*"John Crane" fabricated from DuPont Teflon

John Crane

MECHANICAL PACKINGS

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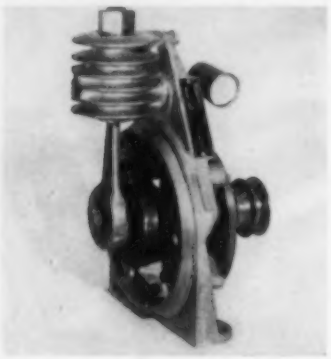
THREAD COMPOUNDS

CRANE PACKING COMPANY



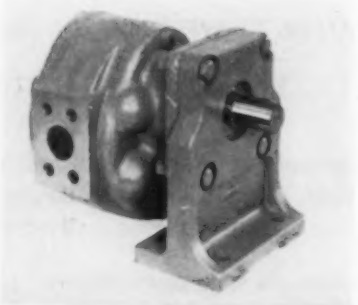
Suitable for use where small volume air is needed at high or low pressure. Can be mounted in any position. Said to be one-half to one-third of the price of pumps with comparable features. **Lee Mfg Co, 226 W 22nd St, Hialeah, Fla.**

Circle 14, Reader Service Card

Continuous bronze bars . . .

solid and tubular, are now being produced in 105-in. lengths. Continuous casting method is said to improve physical qualities of alloy because distribution of lead and other elements is more uniform. Solid bars are available in 21 sizes from ½ to 3 in. dia and tubular bars in 118 sizes from ½ to 2½ in. ID and from 1 to 3 in. OD. **Johnson Bronze Co, New Castle, Penna.**

Circle 15, Reader Service Card



Geared fluid motors . . .

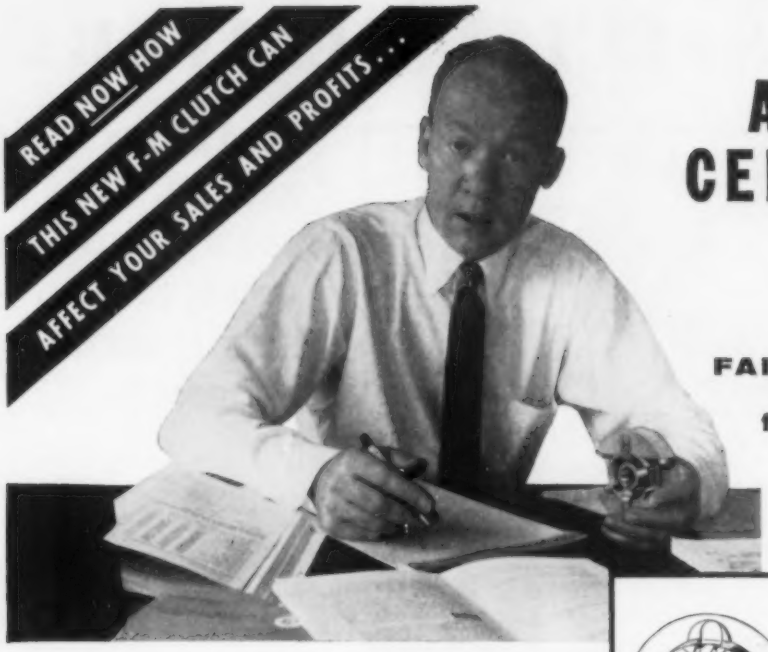
provide 90 to 210 lb-in. torque per 100 psi are for operating pressure to 1000 psi. Available in flange and foot mountings. Ports are designed for SAE split flange connections. **Hydreco Div, New York Air Brake Co, Kalamazoo, Mich.**

Circle 16, Reader Service Card

Miniature ac servomotors . . .

in 60 and 400 cps models are offered in frame sizes 8, 10, 11, 15, 18 and 23. Line includes damping generators, inertia

(Continued on page 112)



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designed by FAIRBANKS-MORSE for the toughest usage you can name

Substantial cost savings for companies who can use it!

Here's an idea for engineers who want to reduce costs for profit improvement.

Simple design and high-volume production of these new clutches for motors and small gasoline engines mean substantial savings to you. And your quantity requirements make little difference in the cost.

If your equipment does not incorporate this starting feature, think of the benefits. Smaller motors can be used for *running* rather than starting loads. It provides low-line voltage protection on jobs where transmission lines are not adequate. You get smooth, gradual pick-up, and the motor is never called on to deliver power below its maximum torque speed. Starting current demand is reduced. It's a foolproof safety device — protects against stalling or overloads, yet does not slip at operating speed.

Gasoline engines may be started easier. The load is automatically applied at the engine's most efficient speed. It prevents stalling and accidental equipment damage.

The new clutch is manufactured in three types — all can be used with a pulley, sprocket, gear, or coupling-type drive on machinery, appliances, and gasoline engine equipment — any application on which automatic start and stop applies. If you already make or buy clutches, couplings, or drives for no-load starting and idling or overload protection, write for Fairbanks-Morse prices and evaluate the cost savings.

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Standard or special— Industrial Timer makes rapid deliveries on all models

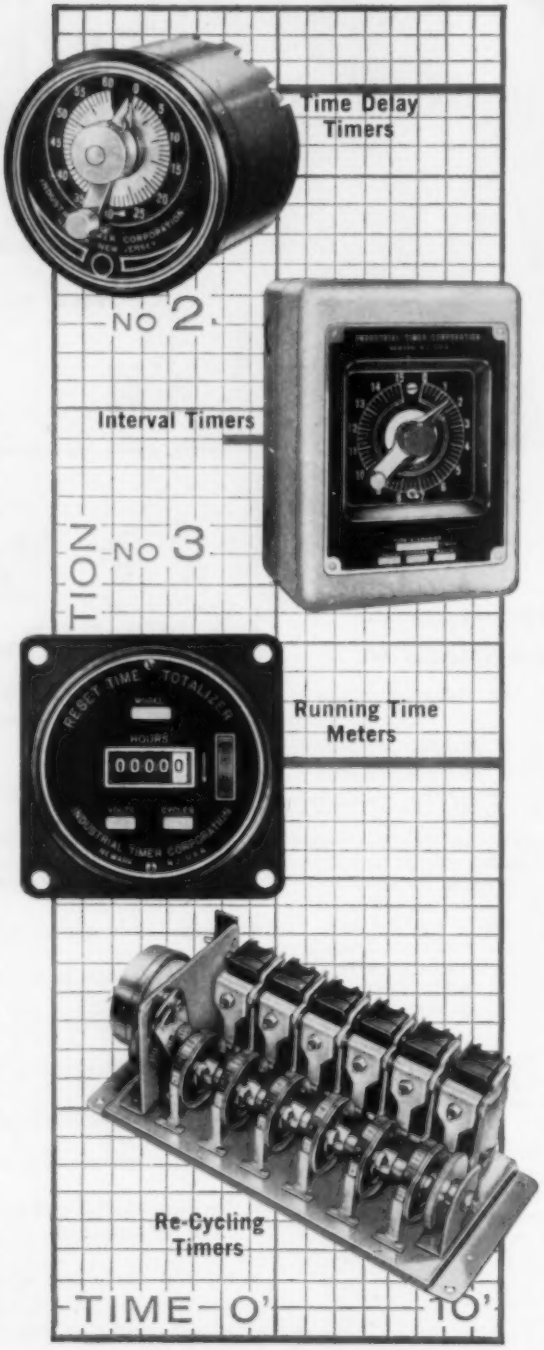
Sometimes you need a standard model timer . . . other times you need a special. Either way we can give you the extra rapid service you may need because of the efficient way we design, manufacture and stock timers for industrial applications.

To meet *all* of the widely varying needs of our customers we manufacture a complete line of timers in the four broad classifications illustrated here:

1. TIME DELAY TIMERS
2. INTERVAL TIMERS
3. RE-CYCLING TIMERS
4. RUNNING TIME METERS

From these we have already developed 20 basic types which can be combined in endless number of ways . . . to date, our engineers have combined them into over 1000 different models. So what might seem to be a special timer requirement to you, will very often be a standard timer in our large stock, and that is the reason we have the ability to fill special orders so quickly. And as far as standard timers are concerned we can give overnight service if necessary.

So, for the utmost in all-round service depend on us for this outstanding combination: deliveries "Immediate on Standards . . . First on Specials".



Speed up your automatic control projects— profit by our timing application experience

No need to let timing problems delay you in your automatic control projects when you can place them with us and get faster solutions. Even though no two automatic control jobs are ever exactly alike, and even though the timer requirements of each are very different we have established an excellent record in helping out in these situations.

20 years of experience in analyzing complex timer applications has provided us with the special knowledge required to give our customers the right answer in near-record time.

Our large stock of standard and combination timers enables us very often to fill orders for these requirements without any time loss because we have already developed so many new combinations specifically for automatic control functions.

Extra special automatic control timer — this calls for original designing. Our engineers will go right to work and get the job done. That's the way we grow and we like it.

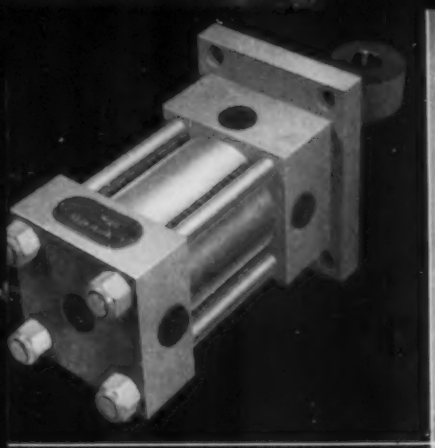
Whatever your control problem, you have everything to gain by submitting it to our timer specialists. They'll come up with the answer — almost with the speed of automatic control itself.

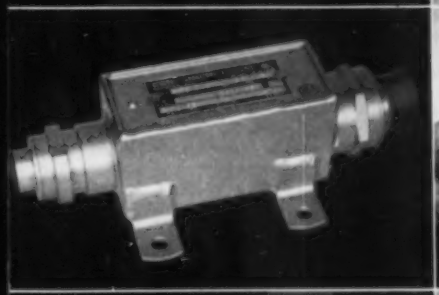
Timers that Control the Pulse Beat of Industry

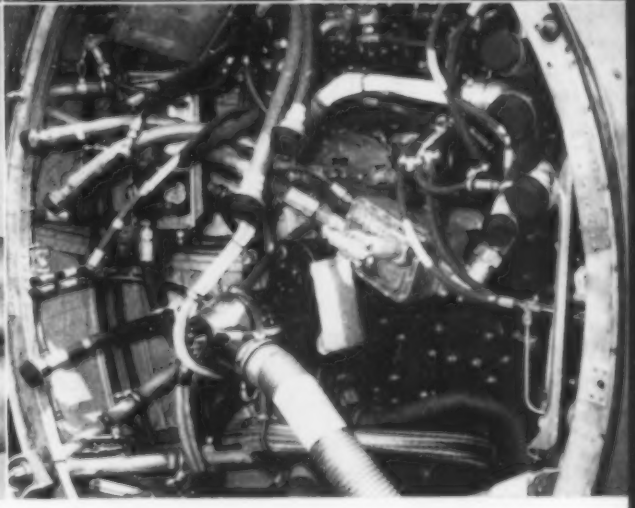
INDUSTRIAL TIMER CORPORATION

1415 McCARTER HIGHWAY, NEWARK 4, N. J.

AFFILIATE—LINE ELECTRIC COMPANY







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Knob reset

- 50 Million Count Life
- 7 watts power consumption—operable in plate circuit of electronic tubes.
- 1000 CPM rating—reliable to 1600 with suitable actuation.
- Quiet—no AC hum.
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Panelmount, knob reset

Panelmount, key reset

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Endurance RATED

Stroke Counters.
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Production Instruments
DIVISION OF GENERAL CONTROLS CO.

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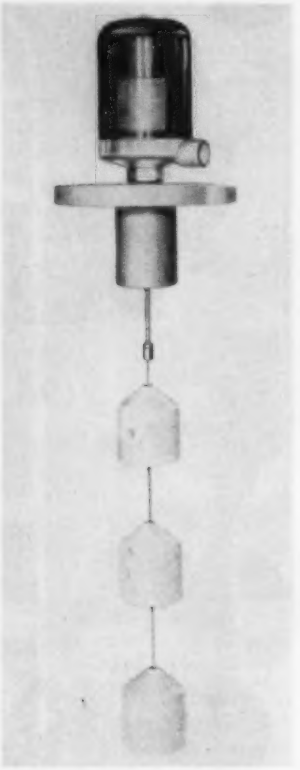
42 Branch Offices and Representatives serving USA and Canada

damped motors, tachometer generators, synchronous motors and various associated gear trains. Said to operate in ambient temperatures to 392 F and to be protected against environmental conditions. Units meet BuOrd specs and conform to military environmental requirements. Servo Dynamics Corp, Somersworth, NH.

Circle 17, Reader Service Card



Two-level liquid control . . . is possible with four top-mounting tandem displacement devices. Models combine functions of two separate controls with one tank opening, providing a wide differential for control of two pumps or one pump and high or low alarm. Switch actuation points can be changed by sliding displacers up or down and locking to stainless steel stranded cable stem. Units are factory-set to requirements with a range of from 0.35 to 1.8 specific gravity, but depending on displacer material. Glazed porcelain displacers are standard. For flanged and screwed mounting. Magnetrol Inc, 2110 S. Marshall Blvd, Chicago 23.

Circle 18, Reader Service Card

Digital indicator . . . with characters 0 to 9 and two blank spaces arranged in sequential ascending order is designed to meet environmental

(Continued on page 116)

ACCEPT NO SUBSTITUTE

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
E. W. Bliss Co., Canton and Toledo, Ohio and Hastings, Mich.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Dayton Casting Co., Dayton, Ohio
Empire Pattern & Foundry Co., Tulsa, Okla. and Bonham, Texas
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundries, Inc., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Kennedy Van Saun Mfg. & Eng. Corp., Danville, Pa.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Nordberg Manufacturing Co., Milwaukee, Wis. and St. Louis, Mo.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Foundries of FMC, Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

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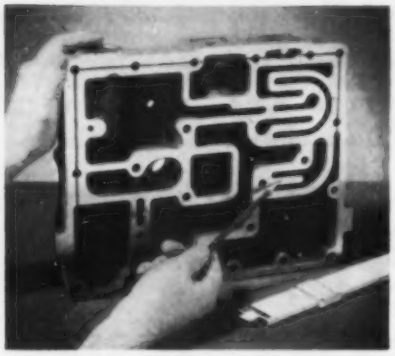
Bulletin 37-A: "Proof That Meehanite Bridges The Gap Between Cast Iron and Steel"
Write today to Meehanite Metal Corporation, Department 7G, 714 North Avenue, New Rochelle, N. Y.

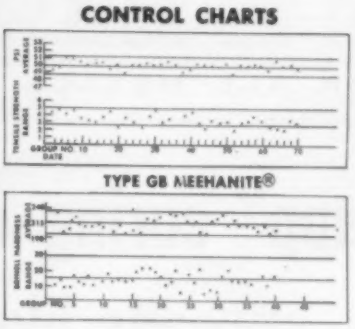
MEEHANITE ®

6 REASONS WHY DESIGN ENGINEERS SPECIFY MEEHANITE CASTINGS



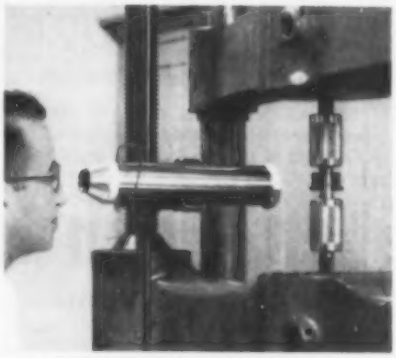
1. CASTING SOUNDNESS

Of all casting properties this is the most important and is the BIG reason engineers specify Meehanite metal. They know from experience that Meehanite castings possess uniform strength and solidity through all sections, regardless of complexity of design or size. This assurance of casting soundness permits them to design with confidence.



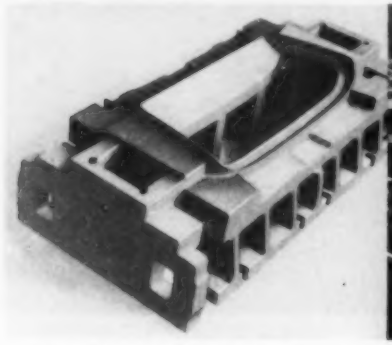
2. FOUNDRY CONTROL

The reliability of castings is measured not by the maximum tensile strength value a foundry can supply in a single casting, but by how consistent the strength values are maintained. Meehanite foundry technique assures delivery of castings that have uniform high strength properties from one to a thousand. This control is vital to the engineer.



3. ENGINEERING PROPERTIES

There are 26 types of Meehanite metal. Each has a distinctive combination of properties which include high elasticity, strength and toughness, excellent impact strength, good damping capacity and superior wear resistance. This makes it easy for the engineer to select the type best suited to his conditions of service.



4. DIMENSIONAL STABILITY

Meehanite metal has found wide favor with design engineers because it exhibits an unusually high degree of dimensional stability in the "as cast" and also in the hardened condition. The ability to cast to close tolerances provides engineers with greater freedom in design and contributes directly to reductions in weight and machining costs.

5. LOW MACHINING COSTS

Engineers striving to cut costs as well as metal, turn to Meehanite®. The uniform structure of Meehanite® permits high speeds and feeds to be used with safety. Freedom from white edges and hard spots increases tool life. Meehanite metal shows a higher strength to machinability ratio than steels or unalloyed irons of equal strength and takes a high polish.

6. OUTSTANDING PERFORMANCE

Meehanite metal is saving Industry thousands of dollars each year in reducing the final cost of the component and increasing service life. A typical example is illustrated. In this application Meehanite metal Tooth Caps for heavy-duty land clearing rakes provide long wear life without failure under severe impact conditions.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

MEEHANITE METAL CORPORATION. NEW ROCHELLE. NEW YORK

News about R&A SINCE 1913 **Adhesives**

FOR ALL METALS AND ALL PLASTICS

New "room temp" curing epoxy adhesive spreads like cold cream

TECHNICAL DATA ON

Bond*master*® M688

A thixotropic, room temperature curing, 100% reactive, two-component, solvent-free modified epoxy adhesive designed for bonding metals and rigid plastics as well as other rigid materials to themselves and to each other.

APPLICATION

Mixed BONDMASTER M688 is soft and buttery, making it extremely easy to spread smoothly and evenly. Once applied, it maintains its form and DOES NOT FLOW during the curing cycle. Excellent for "poor fit" and similar void-filling applications as well as where dripping or running of adhesive cannot be tolerated.

CURE

Bonded assemblies which have been cured at room temperature can be handled in 4 to 6 hours and develop 85% of their maximum strength in 14 to 24 hours. Alternately, where practical, any of the following heat-cure cycles may be used to achieve full strength more rapidly: 100°F for 2 hours; or 150°F for 30 minutes; or 200°F for 15 minutes; or 250°F for 10 minutes. See Technical Data Sheet for alternate hardeners, pot life, cure cycles, etc.

BOND CHARACTERISTICS

Fully cured bonds exhibit minimal shrinkage, are electrical insulators, and provide excellent resistance to weather, galvanic action, and most chemicals, acids, and alkalies.

R&A SINCE 1913

RUBBER & ASBESTOS
CORPORATION

235 BELLEVILLE AVENUE
BLOOMFIELD, NEW JERSEY

Here is why you can save valuable application time as well as material costs with this 100%-reactive, solvent-free epoxy adhesive, BONDMASTER M688:

- Smoothly, easily spreadable with trowel, spatula, knife edge, etc.
- Non-sag (thixotropic) in any position . . . even while curing. Eliminates costly cleanup.
- Cures at room temperature in about 24 hours . . . or in as little as 10 minutes if you can heat to 250°F.
- 100%-reactive . . . no waiting for solvent evaporation . . . mere contact pressure is sufficient.
- Solvent-free . . . no danger of attack on soluble thermoplastics (cells of foamed polystyrene, for example).

ALL METALS—ALMOST ALL PLASTICS

You'll get strong (in excess of 2,000 psi tensile shear on aluminum-to-aluminum, for example) bonds with cast iron, steel, stainless, magnesium, aluminum, copper, brass, bronze . . . *any* metal . . . to themselves or to just about *any* plastic—rigid, foamed, or flexible.

And, of course, to glass, ceramics, wood, and structural laminates based on reinforced melamine, polyester, phenolic, epoxy, etc., resins.

WRITE FOR FURTHER DATA

Write for detailed Technical Data Sheet today. We'll be glad to send a free sample as well if you will describe your bonding problem in detail.

Waldes Truarc Prong-Lock Ring Eliminates Springs, Washers, Takes Up End-Play

WALDES TRUARC
SERIES 5139 RETAINING RING*

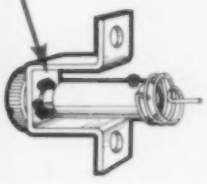
application: external for shafts
range: 3/32" through 7/16"

*U. S. Pat. No. 2,755,698

After radial application, the Waldes Truarc Prong-Lock retaining ring locks and holds securely in its groove by means of two prongs. Because of its resistance to radial displacement, the ring may be used as a shoulder for rotating parts. Thrust-load capacity ranges from 80 to 700 lbs. for sizes from 3/32" to 7/16". Bowed construction provides end-play take-up, often eliminating springs, washers and accessory devices.

Rings replace cotter pins, spring-washers; save $68.00/M

Mason-Neilan Division of Worthington Corp., Norwood, Mass., uses two Waldes Truarc Series 5139 Prong-Lock rings on its pressure controller to secure pivots through which a right angle micrometer adjustment screw passes. Each ring replaces hairpin-type cotter pin and bowed washer... provides necessary tension to prevent adjustment screw from shifting. Manufacturing costs were reduced by $68 per 1,000 units.



Ring replaces locknut, eases control calibration

On a differential pressure control mechanism, Taylor Instrument Companies, Rochester, N. Y., replaced a locknut and eliminated a costly threading operation with a series 5139 Prong-Lock ring. Also eliminated is the loosening and tightening of the locknut before and after each calibration setting. Spring action of the ring securely holds the calibration setting.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get:

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

WALDES
TRUARC®
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me additional information and engineering data for the Truarc Prong-Lock Ring, Series 5139.

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

PN-110

Consult the Yellow Pages of your Telephone Directory for name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

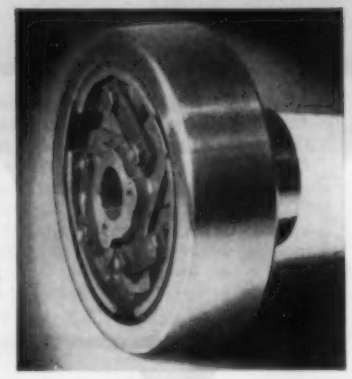
©1958 Waldes Kohinoor, Inc.

CLUTCHES FOR POWER CONTROL DESIGNS

THE NEW HILLIARD-TWIFLEX
Centrifugal Coupling

1
AUTOMATIC
smooth starting with protection against overload shock.

2
FLEXIBLE
in all directions without any loose joints.



3
ADJUSTABLE
to exactly suit the operating conditions.

4
SIMPLE CONSTRUCTION
and easy assembly even in blind installations.

HILLIARD-TWIFLEX Centrifugal Couplings provide automatic shockless power transmission and trouble-free operation even under relatively great misalignment without any lubrication whatsoever.

They are being used very successfully in the drive of compressors—agricultural sprayers—mixers—conveyors—generators—fans and blowers—pumps—hammer mills—crushers—winches and hoists—refrigeration equipment—textile machinery—and wherever smooth, efficient operation is needed.

Tests in a variety of installations for over five years prove the Twiflex is the practical solution to many drive problems.

WRITE TODAY FOR BULLETIN CE-3 WITH COMPLETE INFORMATION.

★ CONSIDER AUTOMATION-INVESTIGATE THESE PRODUCTS

• OTHER HILLIARD CLUTCHES •

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—or intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet or backstop action. Ask for Bulletin 231.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

design engineering show
International Amphitheatre Chicago April 14-17

THE HILLIARD Corporation
MANUFACTURING CLUTCHES FOR OVER 50 YEARS

101 W. FOURTH ST. ELMIRA, NEW YORK

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

tests for military requirements. Furnished in a gasket-sealed enclosure. Indicators may be internally back lit in red or another color. Units may be used separately or in multiples. Sealed unit is $\frac{5}{16}$ x $1\frac{3}{8}$ x $5\frac{1}{4}$ in.; weighs less than 7 oz. Indicators operate as decoding and readout devices, visual and electrical. **Union Switch & Signal, Div of Westinghouse Air Brake Co, Pittsburgh 18.**

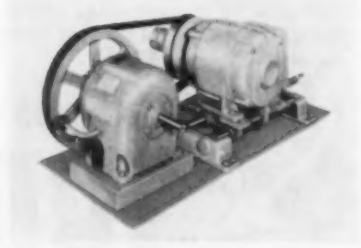
Circle 19, Reader Service Card

Neon pilot lights . . .
for 110 or 200 v ac, as well as other voltages, are said to be more than eight times brighter than NE2 and NE51 units. Finished assemblies, ready for installation and operation, are available in a variety of styles with choice of lens, shape and color, body lengths, terminal leads or lugs and lens markings. Models mount in ½-in. hole with slip-on nut. UL-approved. **Industrial Devices Inc, 982 River Rd, Edgewater, NJ.**

Circle 20, Reader Service Card

Adjustable-speed drives . . .
said to have accuracies previously associated with laboratory instruments are available in ratings through ¾ hp. Regulation of ½ of 1% throughout the speed range to 100:1 is possible. All models can be operated continuously at full torque at all speeds. **Servo-Tek Products Co, 1086 Goffle Rd, Hawthorne, NJ.**

Circle 21, Reader Service Card



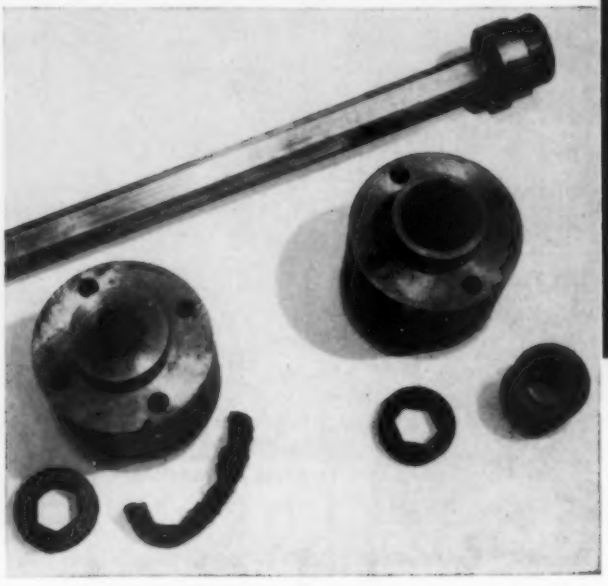
Variable-speed drive . . .
is power by standard 1800 rpm electric motor with self-adjusting variable pitch pulley on motor shaft and belted to a companion pulley on 4-speed transmission input shaft. Drive is available in ½, ¾, 1, 1½, 2, 3, 5 and 7½ hp ratings. Assembly

(Continued on page 120)

"Cast Urethane* parts that outwear steel cut maintenance costs 65% on this pneumatic hammer..."

says H. B. Minturn
Mechanical Superintendent
The Ormet Corporation†

Urethane elastomer components replaced machined steel parts in these pneumatic hammers; show no sign of wear after four months of punishing use, says Ormet's H. B. Minturn (right).



After comparable periods of service, superior wear resistance of cast urethane bushing (right) over machined steel shaft guide with lead graphite packing (left) is obvious. Resiliency of urethane inserts also reduces angular stress on shaft in operation.

"The replacement of steel inserts with cast urethane parts in our pneumatic sand ramming hammers has resulted in a two-thirds reduction in maintenance, with attendant savings in cost of spare parts," says Mr. H. B. Minturn of Ormet Reduction Plant, Hannibal, Ohio.

The steel nose pieces of the rammers, used to tamp a 12-ton mixture of calcine, anthracite coal and foundry coke which lines the cathodes of large electrolytic cells for producing pure aluminum, had a service life of only one to two months. Lead packings lasted less than half that long. "This meant we were losing 2½ hours of potential production time to maintenance every time one of these units had to be torn down to replace the worn parts," Mr. Minturn adds.

"Cast urethane parts have eliminated these problems. The urethane linings in the nose pieces and packing rings seem to be indestructible and show no signs of wear after four months of constant use. The use of urethane parts has given us an added advantage by enabling us to redesign the gasketing to include grease rings which further reduce wear on the shaft and other working parts.

"To sum up, we have really found a tough, friction-resistant material in this elastomer—one which is easily machinable, resilient and low in cost."

†The Ormet Corporation, jointly owned by Olin-Mathieson and Revere Copper and Brass, Inc., is typical of the basic industries that are finding urethane elastomer a ready-made answer to some of their toughest maintenance problems.

MOBAY
CHEMICAL COMPANY
Dept. P-11 • Pittsburgh 34, Pa.

MOBAY
First in Urethane Chemistry

*The exceptional properties referred to in this application story are obtainable only in urethane elastomers made with Mobay's chemicals. Write to Mobay Chemical Company for technical details and sources of fabricating assistance.

CIRCLE 173 READER SERVICE CARD

THERE IS NO SUBSTITUTE FOR SPAULDING FIBRE ON INDUSTRY'S "BENCH"

When industry adds up the qualities of Spaulding Vulcanized Fibre, there is but one conclusion. For countless uses there is no substitute.

No other material combines its forming, punching, insulating and arc resisting qualities. None can compare with its machinability, low heat conductivity, compressibility, abrasive resistance and deionizing properties.

For light weight combined with mechanical strength, Spaulding Vulcanized Fibre stands supreme.

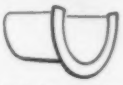
Its applications are endless. Its cost is low. Next time, look to Spaulding Fibre. Learn why it's indispensable to industry.

SPAULDING FIBRE COMPANY, INC.

311 WHEELER STREET
TONAWANDA, N. Y.

***WRITE** US FOR ADDRESS OF OUR NEAREST SALES OFFICE*

For over 25 years no satisfactory substitute has been found for **SPAULDING FIBRE** for these applications



For Cable Bushings
because of its excellent forming and insulating properties plus abrasion resistance.

For Lightning Arrestors
because of its arc snuffing properties and shock resistance.

For Railroad Track End Posts
because of its compression strength and electrical insulation.

For Textile Bobbins
because of its lightweight and smooth wearing qualities.

CIRCLE 175 READER SERVICE CARD→

CLARE Service
which can solve your Wiring Problems

If your present policy is to buy separate relays and switches and perform the necessary wiring yourself, you can benefit from our new, complete wiring service.

From the smallest bench unit to large rack-type cabinets, CLARE can offer packaged wired assemblies to meet your exact requirements. We can build to your specifications, or construct assemblies from our own stock of bases, connectors, plugs, and other components.

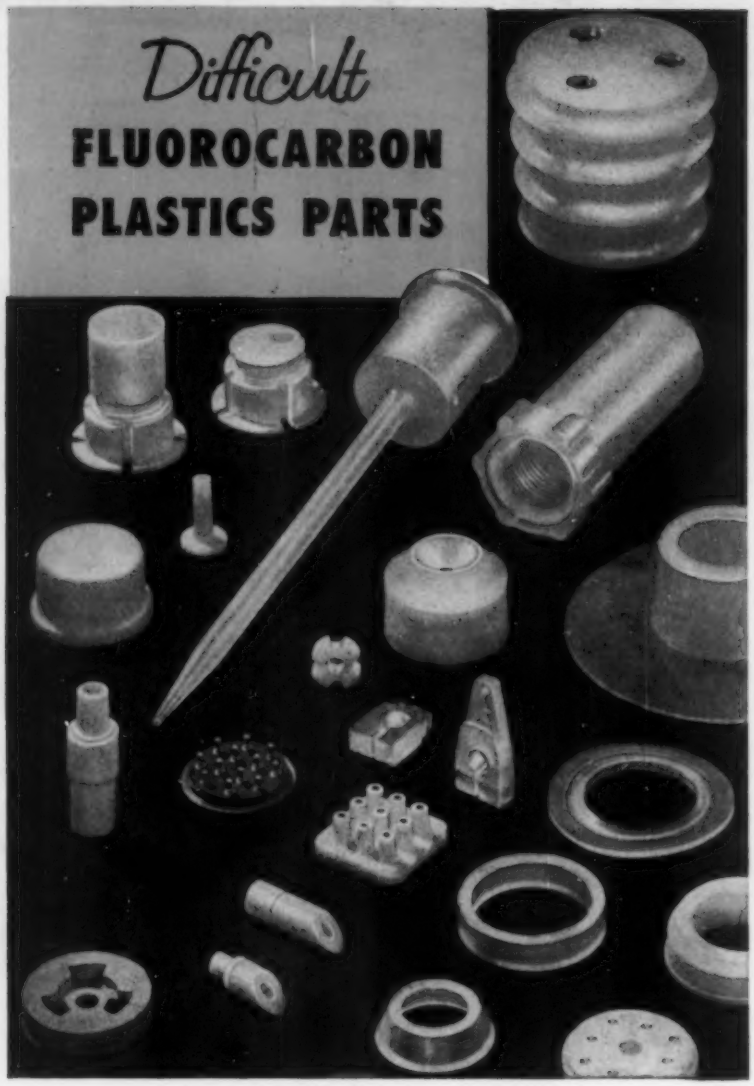
With the opening of our new plant in Fairview, N. C., we now have the capacity to handle any wiring project. Our experience in the care and treatment of precision relays and switches is your assurance of familiar CLARE quality. We have developed our own versatile tooling to provide an *economical* service.

As a result, we can deliver to you wired assemblies which are fully tested and which adhere to the highest standards of quality—and we can do this *more economically* than you could do it yourself.

Why not let us show you how you can fit this special service into your own operation? Call or write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY

CLARE RELAYS

FIRST in the industrial field



■ Gain greater design freedom without penalty in production costs.

Send us your difficult TEFLON* and KEL-F† part problems for quotations. Intricate shapes, inserts, thin sections, molding around metallic structures, threaded parts, precision tolerances—all are routine to U.S.G. production.

Unmatched experience and facilities for cold molding and sintering, injection molding and high speed machining—guarantee the best parts made by the right methods and at the right price, when you come to the pioneers and world leaders in fluorocarbon plastics fabrication.

*du Pont Trademark

†M.M.&M. Trademark

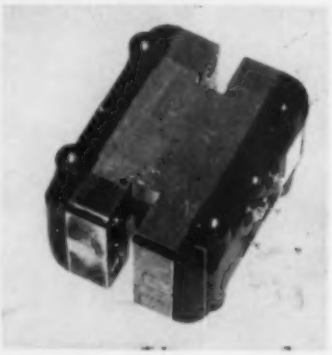
For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

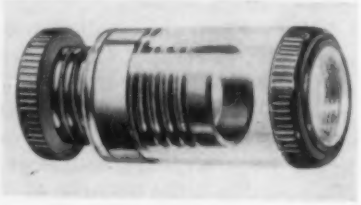
combines several different motors and transmissions for speed variations from 12:1 to 25.7:1. Output speed is varied by turning handwheel on adjustable motor base and allowing V-belt to run at largest dia of variable pitch pulley for max output speed or at min dia for min output speed. In max position, drive is in 1:1 ratio; at min, in lowest gear. Infinite speed adjustment between the max and min are obtained by shifting drive into 2nd or 3rd speed and turning the handwheel. **Lima Electric Motor Co Inc, Dept 145, Lima, Ohio.**

Circle 22, Reader Service Card



Electrical torque motors . . . are used primarily as actuators of hydraulic servovalves, but are suitable for any application where low input current is required to produce substantial force and/or displacement, proportional to that current. Line includes models said to operate under extreme environmental conditions. Five units, with graduated performance specs, vary in size from $1\frac{13}{16}$ x $\frac{13}{16}$ x $1\frac{5}{32}$ in. to $2\frac{1}{4}$ x $3\frac{1}{4}$ x 4 in. Weights range from $4\frac{1}{2}$ to 55 oz. Stroke ranges from 0.005 to 0.020 in., with end-of-stroke force varying from 1 to 8 lb. **American Measurement & Control Inc, 240 Calvary St, Waltham 54, Mass.**

Circle 23, Reader Service Card

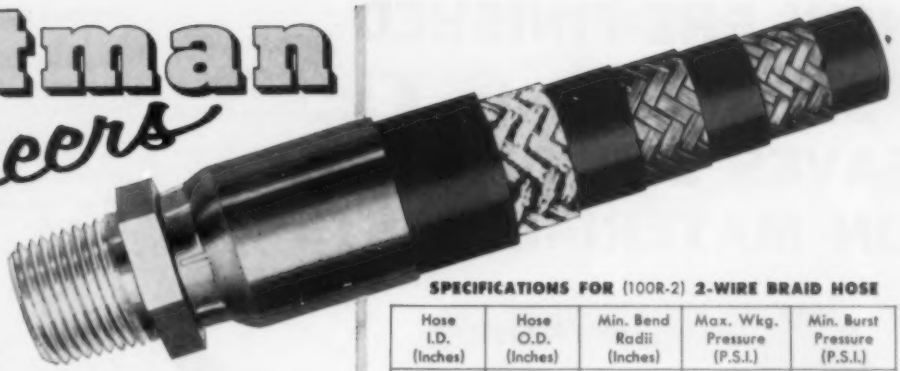


Magnifying comparator . . . for gaging and measuring small parts and objects is said to perform many of the functions of projection-type optical comparators. Needs no additional light source. Magnifier compares part with transparent,

(Continued on page 122)

Eastman

engineers the way TO HIGHER PRESSURES



Eastman engineering is making possible ever-increasing advances in hydraulic pressures through:

- Couplings designed to exceed minimum *burst* pressure —four times actual working pressure.
- Hydraulic application of couplings to hose, assuring maximum grip—within specified hose tolerance.
- Maximum orifice—designed to improve fluid flow, reduce friction and increase power delivery.
- More rigid testing of completed assemblies to reveal additional opportunities for improvement.

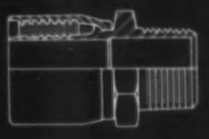
Let Eastman engineers help you increase the "power-performance ratio" of your product to improve your competitive position in your field.

SPECIFICATIONS FOR (100R-2) 2-WIRE BRAID HOSE

Hose I.D. (Inches)	Hose O.D. (Inches)	Min. Bend Radii (Inches)	Max. Wkg. Pressure (P.S.I.)	Min. Burst Pressure (P.S.I.)
¼	11/32	4	5000	20000
3/8	15/32	5	4000	16000
½	19/32	7	3500	14000
¾	1 1/4	9½	2250	9000
1	1 5/16	9½	1875	7500
1 ¼	2	16	1625	6500
1 ½	2 ¼	20	1250	5000
2	2 ¾	22	1125	4500

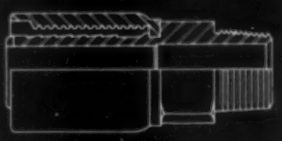
PERMANENTLY ATTACHED COUPLINGS

For 2-wire braid hose. Offers maximum coupling strength, strong hose attachment and improved orifice for rapid, friction-free fluid flow. For working pressures up to 5000 psi. See Pages 10 and 11.



HIGH PRESSURE COUPLINGS

For EXTREME high pressures up to 7000 psi working pressure. Eastman engineered for greater power delivery and performance. For specifications and sizes, send for New Eastman Bulletin 200, below.

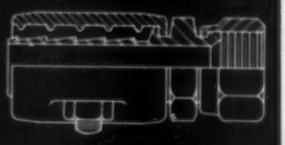


2-PIECE REUSABLE COUPLINGS

For 2-wire high pressure hose up to 5000 psi working pressure. Increases serviceability of your equipment through easy replacement in the field. See new Bulletin for complete details.

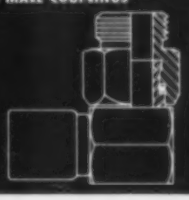
CLAMP TYPE COUPLINGS

Accurate machining assures alternate positioning of clamp ribs between each barb of insert—creating exclusive Inter-Lock grip—available to you only through Eastman. Pages 14 and 15.



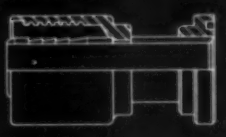
SWIVEL "O" RING MALE COUPLINGS

Permits easy assembly in close quarters, easy positioning of hose in 45° and 90° angles. Economical, reduces number of threaded connections. Dimensional drawings, sizes, and specifications in new Bulletin.



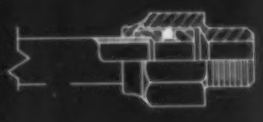
FLANGE HEAD COUPLINGS

Offer advantages of permanent hose attachment plus Split Flange Head Couplings with 0° to 90° stems. Economy plus user convenience. Specifications and sizes listed in new Bulletin.



TUBING ASSEMBLIES

Swivel Male "O" Ring -Tube Nut used on tubing assemblies. Eastman offers formed tubing with beaded or flared ends to your requirements. Specifications and sizes on Page 30.



Eastman

first in the field **MANUFACTURING COMPANY**

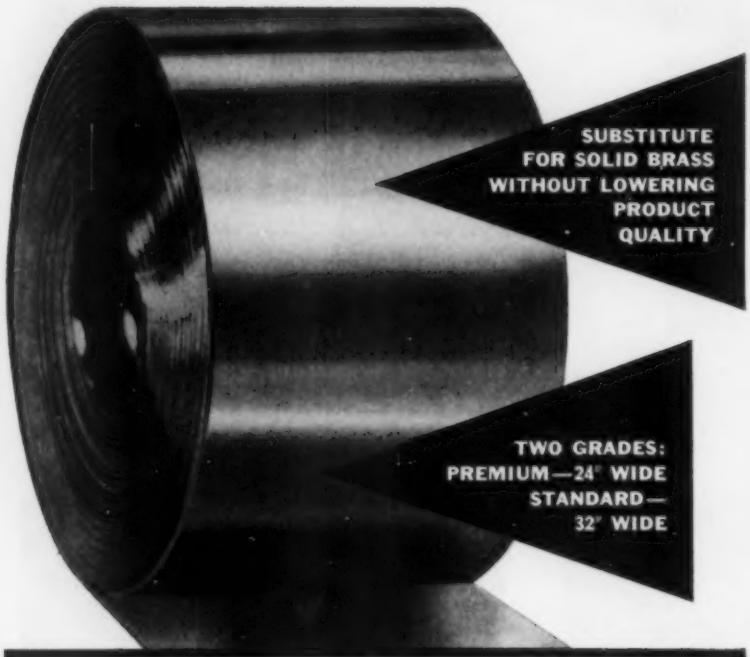
Dept. PE-11, MANITOWOC, WISCONSIN

Write FOR YOUR NEW BOOK— WITH THAT NEW LOOK!

- A NEW Service Concept.
- A NEW High in Convenience.
- A NEW Ease in Specifying— according to your pressure requirements.

SAFEGUARDING AMERICA'S LIFELINES OF MOBILE POWER

NEW PRE-FINISHED BRASS-STEEL SAVES 25% OR MORE ON MATERIAL COSTS



Combines the Decorative Properties of Brass With the Economy of Steel

Where the only BRASS you *need* is the brass you *see*, save 25 percent or more on material costs, reduce production steps with brass-plated steel. This way, the only BRASS you pay for is the substantial brass coating you *really need*. Big 32" wide coils — the widest ever made — in Standard grade, for utility or decorative uses; 24" wide in Premium grade, our finest quality — an economical substitute for pure brass for many applications. Both grades are sealed with BAKEKOTE, a baked resin film. Mar-Not protective coating protects the pre-finished surface during fabrication. Big 24" and 32" wide coils and sheets — bright and satin finishes and crimps. Also stripes in sheets, only.

UNPOLISHED — For those parts designed beyond the fabrication limits of our regular pre-finished material, consider *unpolished* Brass-Steel. Excellent for post-finishing work or for applications where high surface finish is not required.

Write For More Information

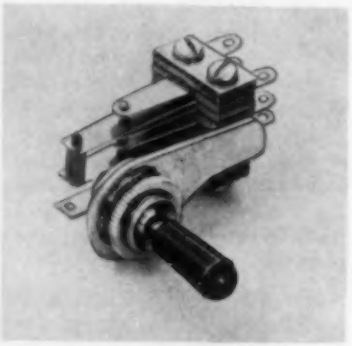
NICKELOID METALS SINCE 1898

AMERICAN NICKELOID COMPANY
PERU 4, ILLINOIS

Mills: Peru, Ill. and Walnutport, Pa. — Sales Offices Throughout the U.S.A.

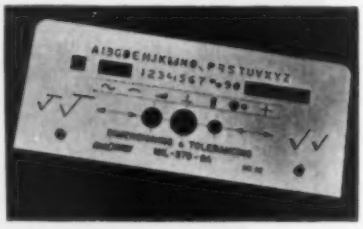
dimensional-scale pattern to determine measurement. Patterns are printed on low-expansion film in pairs, one with black lines and the other with white lines to insure contrast with part. Checks gages, templets, layouts, forms and sizes and is said to show exact wear to be corrected on cutting edges of cutting tools. Supplied in desk and pocket models. With carrying case and 4 pairs of reticles that measure ½ in. by 0.005 in. in decimal divisions; ½ in. by 64ths; 15 mm by 0.1 mm divisions, and full circle protractor by 1° divisions, device is $18.50. Additional reticles, $1 per pair. **Finescale Co, 218 S Western Ave, Los Angeles 4.**

Circle 24, Reader Service Card



Lever-action panel switch . . . is said to require one-fourth usual behind-panel depth. Mechanism has been turned 90° from conventional location. Available in 2 and 3-position, locking and nonlocking, and 3-position locking one side-nonlocking other side-types. Stacked springs are insulated from each other. Silver contacts are rated 3 amp, noninductive, 300 w max. Switch has single hole mounting. **Switchcraft Inc, 5555 N Elston Ave, Chicago 30.**

Circle 25, Reader Service Card



Specification templet . . . contains cutouts for symbols of surface characteristics, flatness, straightness, angularity, parallelism and concentricity. Also, standard sizes of rectangles, circles, a complete alphabet and numbers in ¼-in. size and arrowheads for dimensional lines and standard finishing symbols. 0.030 in. matte

(Contiued on page 126)

"PONY POWER" MOTORS

that give stamina to your products

Lamb Electric ***fractional*** horsepower motors, like the small horses of the famed western-pioneer-day Pony Express, are developed for *stamina.*

Their dependability, and efficiency (optimum weight-size-horsepower ratio) are qualities that result from proper design and careful manufacture by personnel with many years of experience in the small motor field.

May we demonstrate how Lamb Electric Motors can bring these advantages—and also perhaps lower costs—to *your* products?

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

A rugged high-torque, high-speed motor.

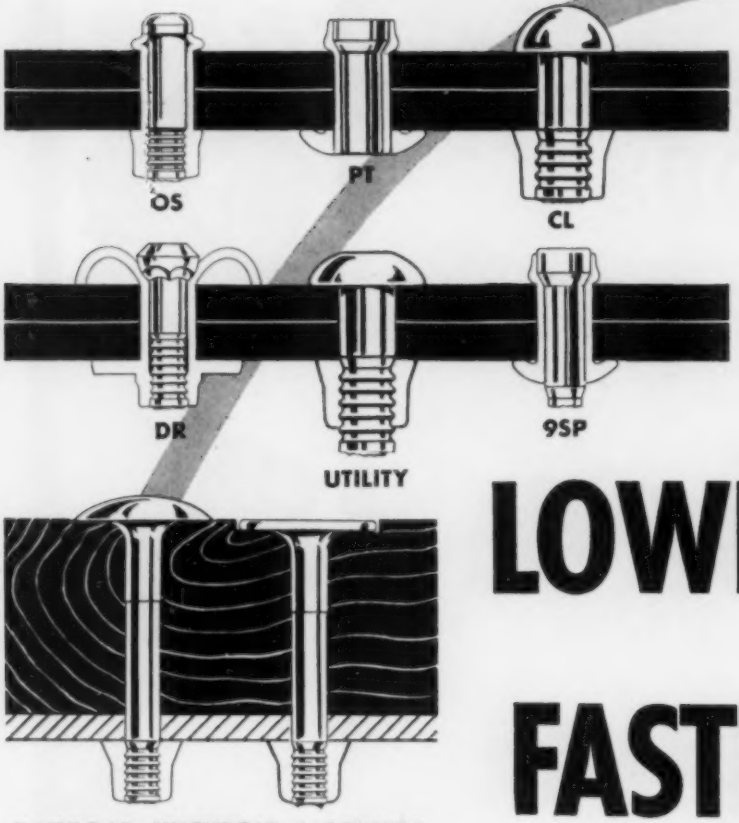
Radar voltage regulator gear motor.

Motor with efficient spur gear speed reducer.

Motor for high-speed grinder.

If you are interested in any of the above motors write and we shall be glad to send full information.

CIRCLE 179 READER SERVICE CARD



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RAILROAD HUCKBOLT FASTENERS

Huck Blind Rivets and Huckbolt Fasteners are well known for their uniform, fast installation—their great strength in shear or tension and their low installed cost.

Approximately sixty per cent of the cost of your fastening operations is in labor. Huck fasteners cut installation time, practically eliminate rejects.

The Huck system takes the guesswork and human error out of fastening, even inexperienced operators can install Huck fasteners at a rate that makes other methods expensive and obsolete. Sturdy, light-weight pneumatic, hydraulic or hand-operated tools do the work easily, uniformly and automatically.

There is a Huck fastener for every requirement—High shear, tension, self-sealing, broad-bearing, close-tolerance, elevated-temperature, etc. Head styles, pin diameters and grip lengths to suit the specific job.

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World's largest manufacturer of blind rivets and precision fasteners.

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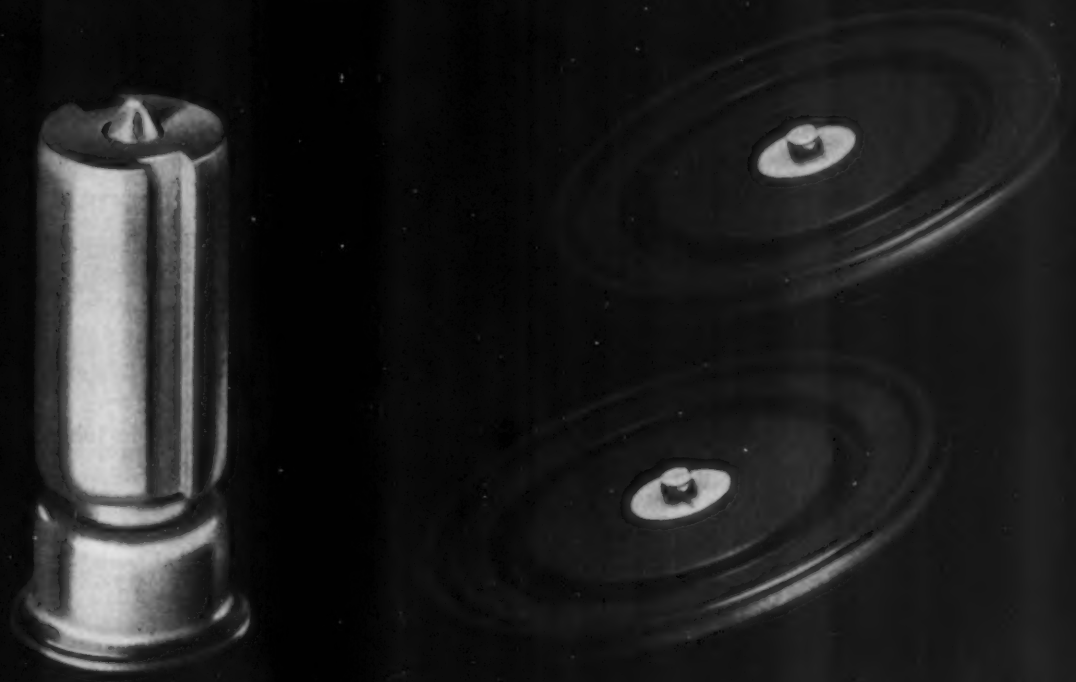

ONLY 3 MOVING PARTS IN ASCO 3-WAY SOLENOID VALVES

Millions of Trouble Free Operations . . . are the result of the simplicity designed into ASCO 3-way solenoid valves. Fewer wearing parts mean substantial savings in maintenance costs . . . reduction in down-time losses.

Simple in construction, ASCO 3-way solenoid valves are simplicity itself in operation—solenoid piloting of two simple diaphragms. Absolutely tight seating is a feature—no closely fitted parts or valve seat grinding are required.

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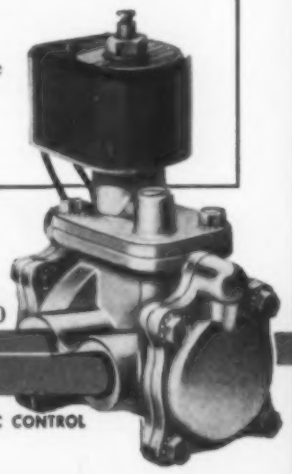

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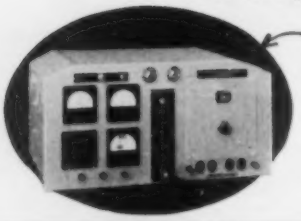
These new Lake Shore Electric developments give you the dependability and economy of simplified design...

with the ruggedness and added convenience of standard components, and NEMA-type housing when specified



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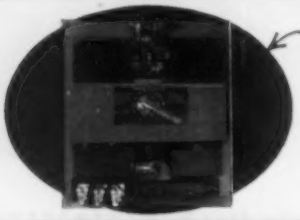
Precision AC or DC controls... fully instrumented for trouble-free service. In top-mount, wall-mount, floor-mount cabs to 600 volts 50-60 cycle AC, 250 volts DC.



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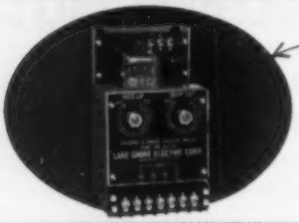
This compact safety transfer switch is of mechanically-linked dual circuit breaker design which permits no neutral position. Full relay protection. To 4000 amps, 600 volts.



differential sensing relays voltage — current — frequency

Here's transistor accuracy and printed circuit ruggedness. Adjustable pick-up and drop-out between 70% and 100% of value with only two screw-type adjustments and standard plug-in relay.

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This rugged transistor design voltage regulator contains no moving parts to cause trouble. Highly accurate and low-cost. Fully warranted for one year. For single generator or parallel service.

where continuous light and power are vital... specify

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finish plastic templet is 6¼ x 2¼ in. Price is $2.50. **Rapidesign Inc, PO Box 429, Burbank, Calif.**

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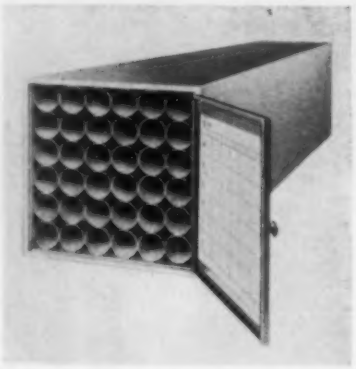

Blueprint file tubes stack . . . in steel file that has contents index record on inside of hinged door and label holder on outside. Each file holds 36 of the 2¼-in.-ID tubes. Files interlock and may be stacked in any number to any height, horizontally or vertically. Finished in hard-baked gray enamel. Complete with file tubes in lengths to accommodate 30, 36, 42 or 60 in. tubes. **Stacor Equipment Co, 295 Emmet St, Newark 5, NJ.**

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1-Step reproduction paper . . . has 100% rag content base stock that cuts easily and evenly. Translucent material is wet-erasable without bleed or feathering when new lines are drawn. Emulsion of the photo-positive paper has fast printing speed and high silver content that is said to produce an image of greater density and contrast. Supplied in extra-thin and transparent vellum grades in rolls to 42 in. wide, spooled to fit all standard reproduction machines, or in cut sheets of any size up to 42 in. wide. Can be processed in ordinary room light, using standard solutions. Paper reproduces opaque as well as translucent original drawings in a single step. **Peerless Photo Products, Inc., Shoreham, NY.**

Circle 28, Reader Service Card

Shirt-pocket slide rule . . . is overlaid with white celluloid on which 23 scales are engine-divided into markings. Furnished in leather case with pocket clip. Trigonometric scales on slide rule are color coded for identification. Log scales cover a range from 0.00005 to 0.999. Two groups of scales are arranged symmetrically. Weighs 1½ oz; measures 6¾ in. long. **Frederick Post Co, PO Box 803, Chicago.**

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Comparative tests prove *Norgren* AIR LINE FILTERS SAVE MAINTENANCE TIME

MAKE	NORGREN	A	B	C	D	E
LOOSE PARTS TO DISASSEMBLE	4	9	16	13	6	12
TOOLS REQUIRED FOR MAINTENANCE	NONE	Wrench	Wrench & Screw-driver	Screw-driver	Wrench	Wrench & Pliers
TOOL OPERATIONS REQUIRED	NONE	2	10	16	2	4

No Tools Required... Fewer Parts to Handle

Compare Norgren with other makes of manual drain filters. All others require tools to take them apart ...then there are a dozen or so loose parts—easily dropped and lost, and likely to be improperly reassembled. Not so with Norgren Filters. No tools are needed for maintenance and there are only four parts to reassemble. Maintenance is simple... an easy job for anyone. This means a big saving in maintenance time and money.

Norgren Filters Provide Top Performance in removing damaging solids and liquids from an air line. Transparent or metal bowls. ¼", ⅜", ½", ¾", 1" pipe sizes.

If it's Norgren... It's Dependable.

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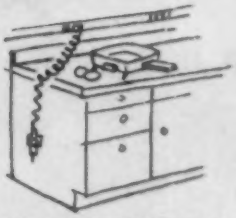
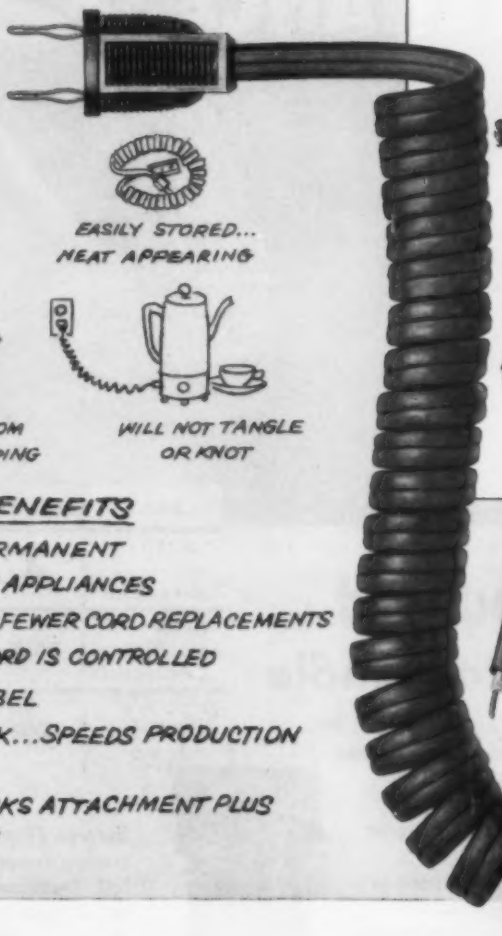


HOLDS THERMOSTAT IN SUSPENSION IF DROPPED



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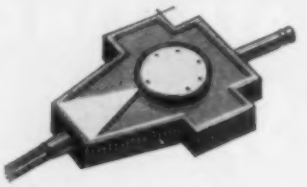

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For Electric Heaters and Small Appliances

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

TEFLON HOSE AND ACCESSORIES—Catalog 103, 66 pp. Dimensional information, specifications, characteristics and assembly instructions about medium and high-pressure hoses and fittings for aircraft applications. Selector chart gives specifications about hose recommended for various applications. Aeroquip Corp, Jackson, Mich.

Circle 30, Reader Service Card

ALLOY STEELS—Booklet 415-C, 44 pp. Collection of facts about alloy steel, now in fourth edition. Quick reference includes nine tables of AISI and SAE specifications for open-hearth and electric furnace alloy steels. Bethlehem Steel Co, Bethlehem, Penna.

Circle 31, Reader Service Card

DRY FLUID DRIVES—Bulletin A-640B, 24 pp. Describes line of 10 stock couplings and 8 stock drives from fractional to 1000-hp ratings. Includes selection tables, operating characteristics and accessory data. Dodge Mfg. Co, Mishawaka, Ind.

Circle 32, Reader Service Card

SELECTOR FOR LIQUID-LEVEL GAGES, VALVES—Pocket-size slide selector. Gives size numbers, visible glass and center-to-center connections for gages in all types and pressure groups. Also, individual pressure-temperature graphs on each type of gage, illustrations of various gage-valve combinations and cross-section illustrations and data on various valves. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

Circle 33, Reader Service Card

MINIATURE PRESSURE SWITCHES—Catalog CEI-602, 28 pp. Describes and illustrates line, now including an absolute pressure type. Includes general characteristics, performance data, dimensional drawings, application and installation information and general glossary of terms. Century Electronics & Instruments Inc, 1333 N Utica, Tulsa, Okla.

Circle 34, Reader Service Card

STOCK BOXES AND COVERS—Catalog B, 20 pp. Dimensions and specs of deep-drawn aluminum boxes and covers, supplemented by dimensional drawings. Zero Mfg. Co, 1121 Chestnut St, Burbank, Calif.

Circle 35, Reader Service Card

SPECIFYING STEEL TUBING—Folder TDC-186, 4 pp. Cross-reference between type of steel, application and specifications. ASTM specs for applications covered are included. Tubular Products Div, Babcock & Wilcox Co, Beaver Falls, Penna.

Circle 36, Reader Service Card

STOCK HYDRAULIC AND PNEUMATIC INSTRUMENTS—Catalog 2, 52 pp. Covers indicators, transmitters, recorders and controllers for flow, pressure, temperature, density, viscosity and consistency. Includes dimensional drawings and sizing nomographs for variable-area flowmeters. Fischer & Porter, 941 Jacksonville Rd, Hatboro, Penna.

Circle 37, Reader Service Card

COMMUTATORS AND COLLECTOR RINGS—Catalog 65, 48 pp. Lists dimensions of commutators in tabular form, commutator problems and common causes. Design information on ordering is also included. Toledo Commutator Co, Owosso, Mich.

Circle 38, Reader Service Card

SPRAYED METAL AND CERAMIC COATINGS—Bulletin 136A, 8 pp. Covers basic characteristics of coatings, including hardness, tensile strength, comparative shrink, bond strength and spraying data, such as speeds, material and gas consumption and sq ft covered per hour. Applications are described. Metallizing Engineering Co Inc, 1101 Prospect Ave, Westbury, NY.

Circle 39, Reader Service Card

AIR AND HYDRAULIC CYLINDERS—Bulletins S2-58B and SR2-57A, 8 and 12 pp. Construction features, specifications, dimensional data, mounting and ordering information on Series S-2 heavy-duty air cylinders, T-2 general purpose hydraulic cylinders and R-2 air and hydraulic cylinders. Supplemented with cutaway view and dimensional drawings. Hydro-Line Mfg Co, 5600 Pike Rd, Rockford, Ill.

Circle 40, Reader Service Card

ADHESIVES FOR ELECTRICAL USES—File folder, 14 pp. Contains technical bulletins on cements, adhesives and sealants particularly applicable to electrical and electronic assemblies. Information on physical and electrical properties and

(Continued on page 133)

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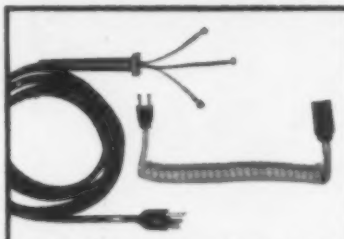

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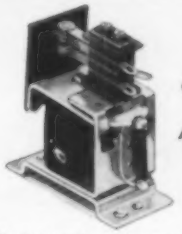

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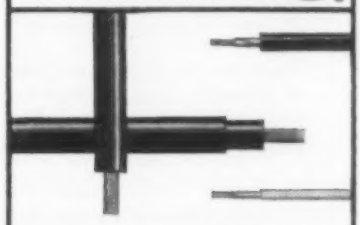

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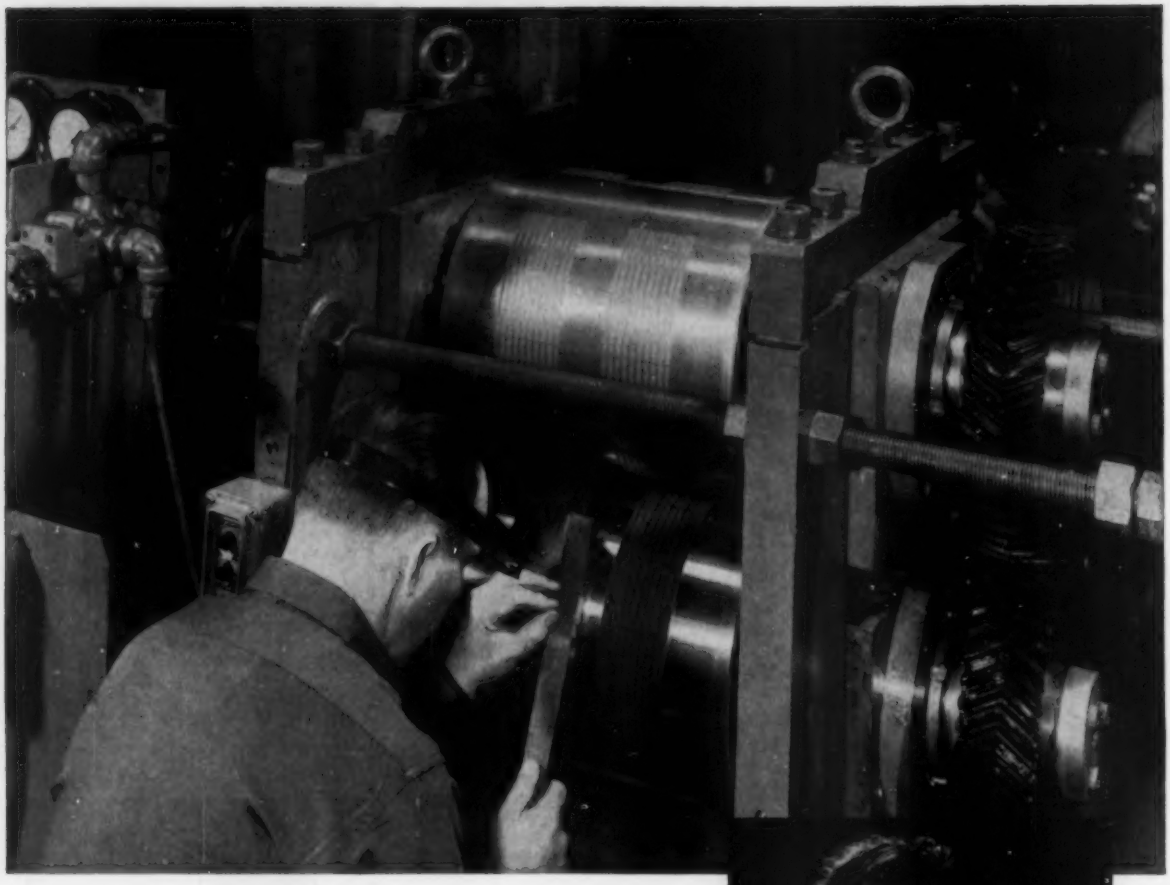

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That's why we at Standard have geared ourselves to give Alclyde the quality perfection and service it requires. In fact, it's the *service* we can give that all of our customers particularly appreciate. Won't you discuss your quality *and* service requirements with us? Write Dept. 4-L.

"Yes, Standard Steel Works, in supplying us with matched, flame-hardened forged steel embossing rolls, meets our rigid specifications for steel analysis and accurate machining. Nothing is more vital to an engraver than to have perfection all along the line. But in addition, we appreciate the warm, personal relationship which exists between us. The people at Standard appear to be really interested in our business and problems," says Frank W. Broderick, president Alclyde Engraving Co., Chatham, N. J.

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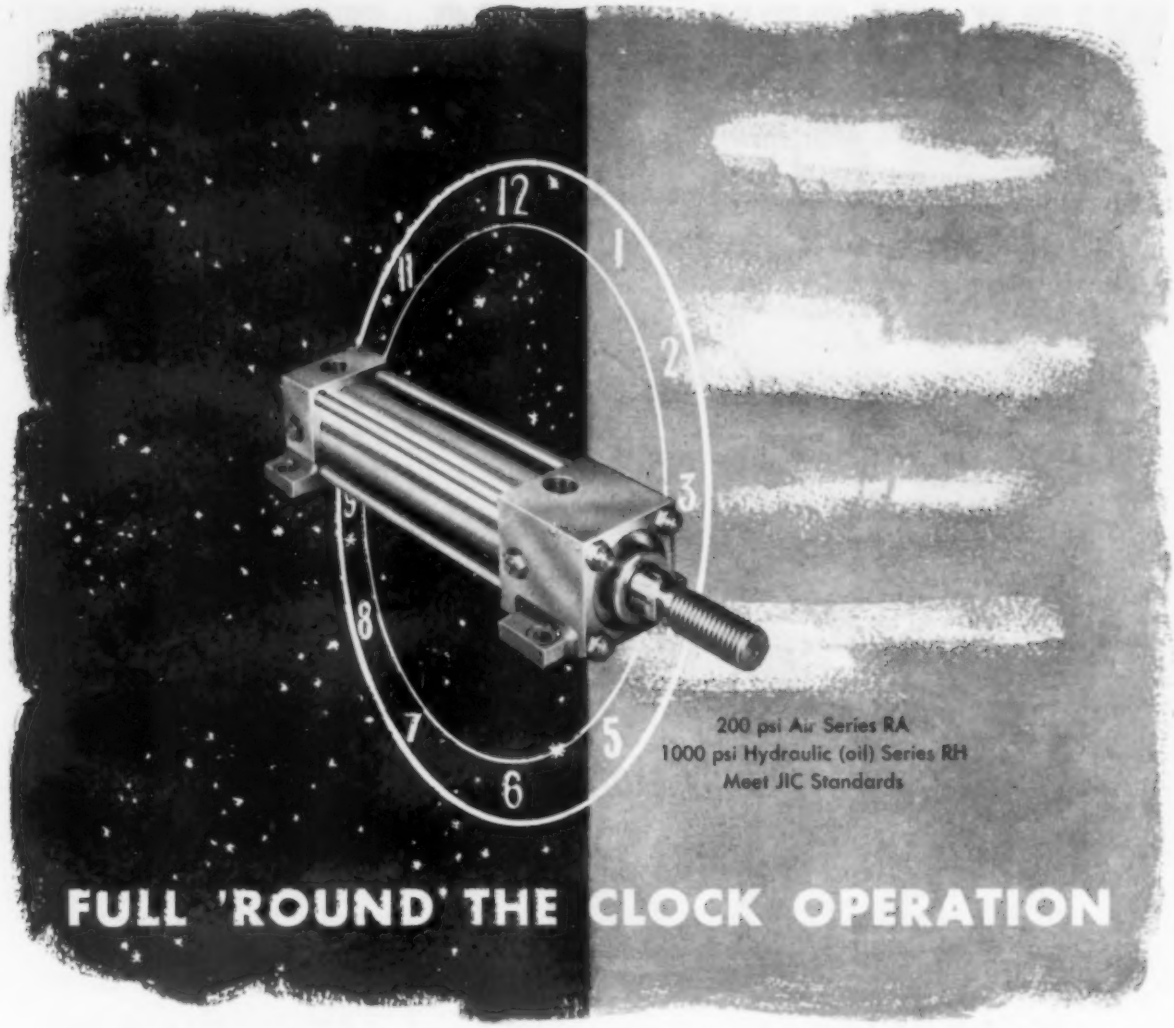

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CIRCLE 187 READER SERVICE CARD 131

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If you need localized heat under close thermal control — for dies, platens, instrumentation or other process equipment — HOTWATT Cartridge Heaters are the dependable, economical answer.

The unique production system employed by HOTWATT offers a wide range of standard cartridge heating units . . . there is a size, sheath, lead or terminal, wattage and voltage to meet your requirements.

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HOTWATT® Cartridge Heaters are made in diameters from ¼" up, lengths as desired. Customized units and ceramic heaters in long or short runs without extra design charge. When you need heat in a hurry — call HOTWATT® for the fastest delivery in the industry.

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Circle 41, Reader Service Card

BATTERY CONNECTORS – Catalog GB-7-2958, 20 pp. Describes line of connectors, with exploded views and dimensional drawings. Cannon Electric Co, 3208 Humboldt St, Los Angeles 31.

Circle 42, Reader Service Card

EXPLOSIONPROOF TIMING CONTROLS–Bulletin 800, 8 pp. Gives specifications, applications, circuit diagrams, dimenisonal drawings and photos for each type. Industrial Timer Corp, 1407 McCarter Highway, Newark 4, NJ.

Circle 43, Reader Service Card

SQUARE AIR CYLINDERS – Catalog SA7, 20 pp. Gives design features, specifications and dimensions of nonrotating, double-acting cylinders. With cutaway views, photos, dimensional drawings. Lynair Inc, 3100 E Michigan, Jackson, Mich.

Circle 44, Reader Service Card

STAINLESS STEEL QUICK COUPLERS–Catalog F-10-R, 8 pp. Construction, recommended operating conditions chemical service applications, dimensional data. OPW Corp, Jordan Industrial Sales Div, 6013 Wiehe Rd, Cincinnati 13.

Circle 45, Reader Service Card

TUBULAR PRODUCTS–Bulletin 12, 16 pp. Information on types, grades, lengths, finishes, mechanical properties and characteristics of small-diameter stainless steel, nickel and nickel alloy tubing, special metals and alloys and fabricated tubular parts. J Bishop & Co, Malvern, Penna.

Circle 46, Reader Service Card

LUBRICANTS, GREASES, OILS–Booklet, 12 pp. Lists all industrial products offered. Reply card is included for inquries on products. Sun Oil Co, Industrial Products Dept, 1608 Walnut St, Philadelphia 3.

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INTEGRAL CASTING OF INTERNAL TUBELESS PASSAGES–Bulletin, 8 pp. Describes and discusses design potential of casting process using light alloys. Originally presented by G. Sandenburgh, manager of engineering, as a paper to Society of Aircraft Materials and Process Engineers and Magnesium Assn. Hills-McCanna Co, 2411 W Nelson St, Chicago 18.

Circle 48, Reader Service Card

ELECTROMECHANICAL ASSEMBLY COMPONENTS–Catalog TDS 1110-1, 16 pp. Contains information and specifications of all components, available indi-

(Continued on page 136)

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Do you have a design problem? Maybe Amplex has the answer. Write for detailed information about Amplex powder metal components—OILITE Bearings, Parts, Filters. Or call your nearest engineering representative listed in the yellow pages under "Bearings—OILITE." Address Dept. A-11.

Representatives and dealers located in principal cities in United States and Canada.

A CHRYSLER OILITE PRODUCT

Only Chrysler Makes **OILITE**

AMPLEX DIVISION

CHRYSLER CORPORATION • DETROIT 31, MICHIGAN

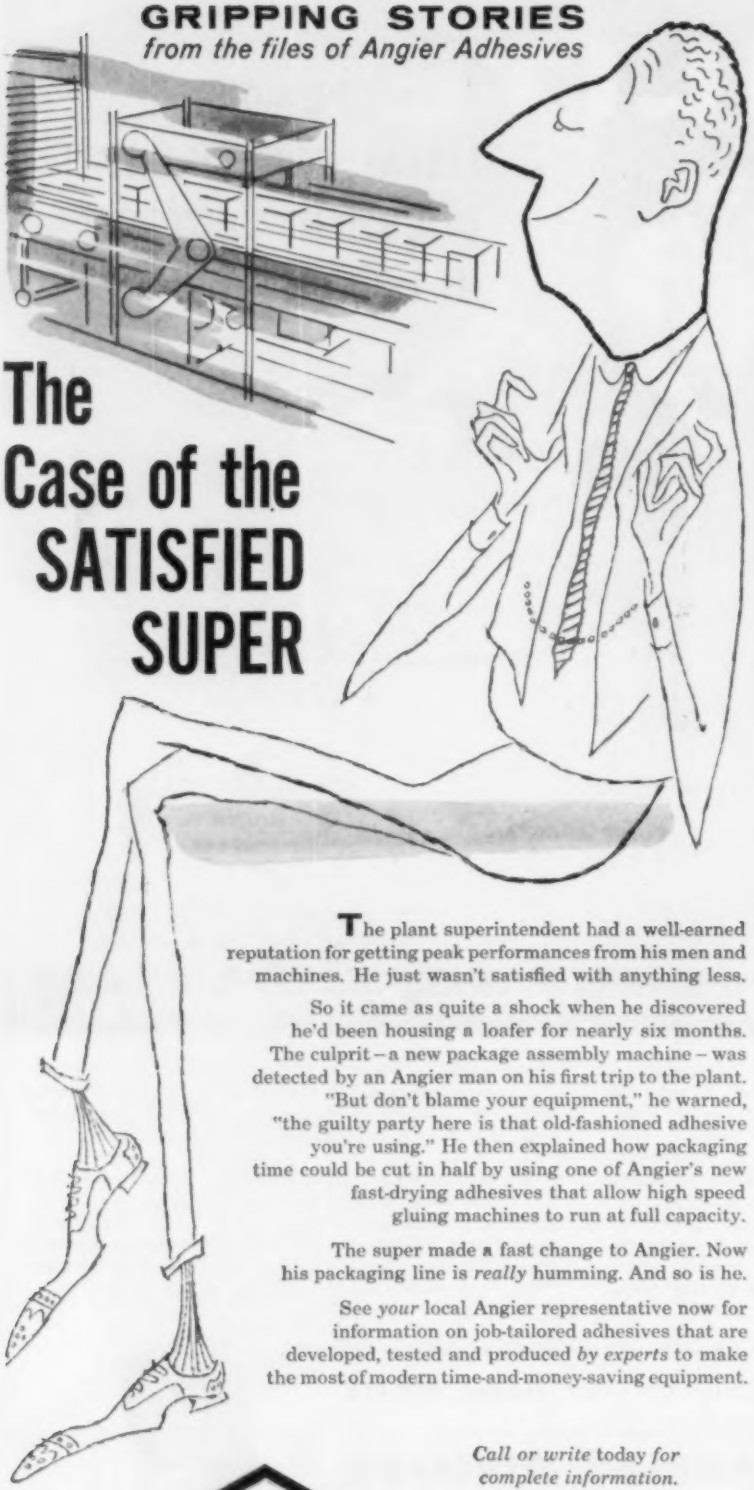
New 24 page OILITE bronze bearing stock list. Contains over 1000 sleeve, flange and thrust bearings—cored, bar and plate stock —engineering data. Write for booklet S-56.

Bearings • Finished Machine Parts • Permanent Metal Filters • Friction Units

Ferrous and Non-Ferrous Metals

No. 4 of a Series

GRIPPING STORIES
from the files of Angier Adhesives



The Case of the SATISFIED SUPER

The plant superintendent had a well-earned reputation for getting peak performances from his men and machines. He just wasn't satisfied with anything less.

So it came as quite a shock when he discovered he'd been housing a loafer for nearly six months. The culprit – a new package assembly machine – was detected by an Angier man on his first trip to the plant. "But don't blame your equipment," he warned, "the guilty party here is that old-fashioned adhesive you're using." He then explained how packaging time could be cut in half by using one of Angier's new fast-drying adhesives that allow high speed gluing machines to run at full capacity.

The super made a fast change to Angier. Now his packaging line is *really* humming. And so is he.

See *your* local Angier representative now for information on job-tailored adhesives that are developed, tested and produced *by experts* to make the most of modern time-and-money-saving equipment.

Call or write today *for complete information.*

ANGIER ADHESIVES

INTERCHEMICAL CORPORATION
Finishes Division
120 Potter St., Cambridge 42, Mass.
Midwestern Plant: HUNTINGTON, IND.

vidually in production lots or in 4 types of kits. Servo Corp of America, 20-20 Jericho Turnpike, New Hyde Park, NY.

Circle 49, Reader Service Card

RESIN-IMPREGNATED REINFORCING MATERIALS–Bulletin 1100, 8 pp. Mechanical and physical properties and recommended fabrication techniques for glass cloth impregnated with a high-temperature phenolic resin. Eli Sandman Co, 280 Greenwood St, Worcester, Mass.

Circle 50, Reader Service Card

ELECTRON OPTICAL INSTRUMENTS–Brochure RC 178A, 16 pp. Text discusses operation and application of two electron microscopes, an X-ray microscope and a contact microradiographic unit. Photos, micrographs and diagrams show details of construction, accessories and applications. Philips Electronics Inc, Instruments Div, 750 S Fulton Ave, Mount Vernon, NY.

Circle 51, Reader Service Card

VARIABLE-PITCH DRIVES–Catalog V-183-B, 12 pp. Performance information, dimensions and prices for drives and transmission accessories. Browning Mfg Co, Maysville, Ky.

Circle 52, Reader Service Card

MINIATURE ELECTRICAL CONNECTORS–Catalog KM-1, 12 pp. Describes materials and finish, alternate insert arrangements, and bell and connector shell variations, gives ordering information. Cannon Electric Co, 3208 Humboldt St, Los Angeles 31.

Circle 53, Reader Service Card

AXIAL-FLOW FANS–Bulletin 5802, 4 pp. Gives electric motor specifications in tabular form and describes construction. Lists applications. Pesco Products Div, Borg-Warner Corp, Bedford, Ohio.

Circle 54, Reader Service Card

METAL STAMPINGS–Booklet, 4 pp. Discusses technique and facilities for metal stampings giving illustrated examples of cost savings. Dayton Rogers Mfg Co, 2824 13th Ave S, Minneapolis 7.

Circle 55, Reader Service Card

BLIND-BOLT FASTENER – Brochure 8-389, 4 pp. Discusses design, specs of protruding head and countersunk head fasteners. Gives hole tolerance specs and installation tool recommendations. Huck Mfg Co, 2480 Bellevue Ave, Detroit 7.

Circle 56, Reader Service Card

SILICON SOLAR CELLS–Bulletin 32-58, 4 pp. Gives electrical and physical characteristics, design parameters and application notes on nine types of cells. Illus-

(Continued on page 140)

Lightweight miniature Servotran variable speed drive

...ideal for actuators, computers, recorders

Here's the remarkable new Servotran variable speed drive—so small it can fit in the palm of your hand! It offers frequency response equivalent to a hydraulic system and *triple* that of an electrical system in a dependable mechanical drive weighing only 1¾ pounds. A maximum of only two inch ounces on the control shaft changes speed from full forward to full reverse in .05 second. Output torque is constant and efficiency is between 85% and 95%.

MODIFICATIONS

The drive without motor is only 3¾ in. long by 2 in. in diameter. It is available with several modifications to meet specific needs. Positive speed adjustment can be obtained by using an accurately calibrated dial. A flexible push-pull cable for manual remote control and solenoid control for electrical remote control can be supplied.

APPLICATIONS

Applications for the new miniature Servotran are limited only by the imagination. In actuators, computers, recorders, integrators and in airborne instrumentation—for any application where low torque shifting, higher efficiency, wider speed range and low noise levels are important—investigate the remarkable new Servotran variable speed drive.

SEND FOR INFORMATION

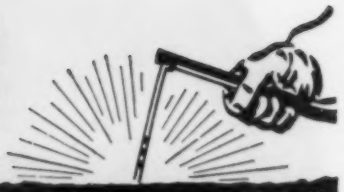
For information write today to Humphrey Products Division, Dept. P-118, 3794 Rosecrans Street, San Diego 10, California.

Humphrey Inc.

HUMPHREY PRODUCTS DIVISION

3794 ROSECRANS STREET, SAN DIEGO 10, CALIFORNIA

Weldynamics



ARC WELDING AT WORK CUTTING COSTS

Switch from cast iron to welded steel saves 61% on blower hubs

Because steel is 3 times stronger, 2½ times more rigid and costs ⅓ as much as cast iron a blower manufacturer was able to cut costs of blower hubs 61%.

Additional advantages of welded steel are:

- 42% lighter permitting use of lighter bearings and shafts
- Higher maximum speeds—no danger of fracture
- Easier balancing
- Better appearance

Your product can be made better at less cost with welded Steel. A Lincoln man trained in Weldynamics will help you. Call or write.

DESIGN AIDS!

"Procedure Handbook of Arc Welding Design and Practice" new 11th edition has 1300 pages, 1100 illustrations, 240 pages on Machine Design. $3.00 postpaid in U.S.A., $3.50 elsewhere.

Send for Machine "Design Ideas", free to engineers and supervisors.

Machine Design Seminars, conducted at our Cleveland Plant.

(Top) *Blower rotor with cast iron hub attached by rivets.*

(Bottom) *Same size rotor with welded and spun steel hub attached by intermittent welds.*

The World's Largest Manufacturer of Arc Welding Equipment

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WHERE CAN H & H METALFLO SAVE YOU MONEY?

1. Shower curtain rods
2. Fishing rod ferrules
3. Fireplace fixtures
4. Towel bars

H & H Metalflo, the economical brazed brass tubing originated by H & H Tube and Manufacturing Company, is today being used successfully in a wide variety of applications where previously more expensive seamless tubing had been used. So why not take another look at some of your own products. Perhaps, H & H Metalflo can save *you* money too.

H & H TUBE AND MANUFACTURING CO.

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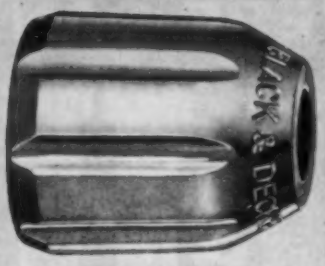
METALFLO LOCKSEAM COIL STRIP SEAMLESS TUBING TUBULAR PARTS

now

you can get this brilliant finish directly on zinc die castings!

No electroplating--no mechanical finishing!

PART AS CAST



TREATED WITH NEW IRIDITE

NEW IRIDITE® (Cast-Zinc-Brite)

brightens zinc die castings by chemical polishing, protects against corrosion

NOW, FOR THE FIRST TIME you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

CORROSION RESISTANCE, TOO! New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

AS A BASE FOR ELECTROPLATING—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.*

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trated with performance curves and a magnified view of cell construction. Semiconductor Div, Hoffman Electronics Corp, 930 Pitner Ave, Evanston, Ill.

Circle 57, Reader Service Card

COMPONENT DRY-TYPE TRANSFORMERS—Bulletin GEA-6723, 24 pp. Guide to selection of small power and control, general and special-purpose transformers. Describes and illustrates each transformer type, including typical ratings, prices and application information. General Electric Co, Schenectady 5.

Circle 58, Reader Service Card

CONVERSION OF ANGLES TO LINEAR MEASUREMENT—Wallet-size plastic chart shows conversion of small angles to microin. per in., per 10 in. and per ft; and linear measure from 1 microin. to 0.005 in. in terms of min., sec and fractional sec per in., per 10 in. and per ft. Engis Equipment Co, 431 S Dearborn St, Chicago 5.

Circle 59, Reader Service Card

SNAP-ACTING SWITCHES—Bulletins 958SS and 858A, 2 and 4 pp. Describes sealed subminiature and precision snap-acting switches. 958SS shows standard and auxiliary actuator styles. Gives force and movement specs and electrical ratings. 858A contains force and movement specs, electrical ratings, circuit arrangements. Unimax Switch Div, W L Maxson Corp, Ives Rd, Wallingford, Conn.

Circle 60, Reader Service Card

INSULATION ADHESIVES AND SEALERS—Catalog, 4 pp. Describes four typical insulation adhesive and sealer applications. Properties, uses, application methods and coverage are given. Adhesives, Coatings and Sealers Div, Minnesota Mining and Mfg Co, 423 Piquette Ave, Detroit 2.

Circle 61, Reader Service Card

PORCELAIN ENAMEL FINISHING—Brochure SC-58, 4 pp. Describes applications and properties of coated metal parts. Erie Ceramic Arts Co, Sales Dept, Erie, Penna.

Circle 62, Reader Service Card

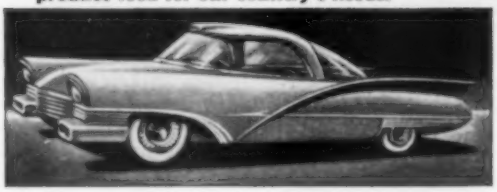
OIL HYDRAULIC AXIAL-PISTON PUMPS, MOTORS—Bulletin 5301, 4 pp. Includes dimensions, specs and performance data for 18 different sizes of units, as well as performance curves. Vickers Inc, Marine and Ordnance Dept, Waterbury 20, Conn.

Circle 63, Reader Service Card

ELECTROFORMING—Brochure, 6 pp. Describes basic principles of fabricating metal parts. Pictures typical parts. Electroforms, 239 E. 165 St, Gardena, Calif.

Circle 64, Reader Service Card

The steel plowshare was the basic agricultural tool when Wyman-Gordon was established seventy-five years ago. At that time, it took approximately 50 per cent of the nation's work force on farms to produce food for our country's needs.



With today's mechanical farm implements, it requires only 12½ per cent to feed our people. The development of modern farm implements, motor cars, trucks and tractors, railroad locomotives, and the "Mach era" aircraft and space vehicles, would have been impossible without forgings.

Whenever the ultimate is required in power, speed, endurance or reliability there is no substitute for a forging. Today, as for seventy-five years, Wyman-Gordon continues in the forefront in new forging developments.

WYMAN-GORDON COMPANY

ESTABLISHED 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS
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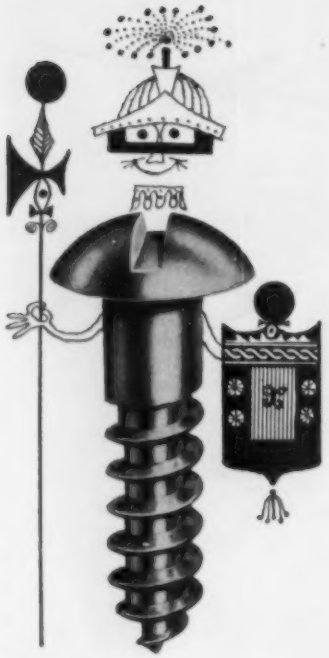

YOU'RE PROTECTED...FROM UGLY CORROSION STAINS WITH ALCOA ALUMINUM FASTENERS

Don't let ugly corrosion stains spoil the appearance of your products. Make them of aluminum, fasten them with Alcoa® Aluminum Fasteners for lasting sales appeal. Low-cost, carefree aluminum fasteners protect your aluminum products against both galvanic and atmospheric corrosion. And they are readily available in complete stocks . . . all standard sizes and types at your local Alcoa distributor; or call your nearest Alcoa sales office. Look in the Yellow Pages of your telephone directory. ALCOA IS A "NATURAL" FOR SPECIALS, TOO!

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tangents...

The Editor is Jiminy Cricket

Periodically, I am startled by someone who believes a technical editor is just a shipping clerk—a necessary but exasperating function between author and printer. The mental attitude of some authors is clear: "Oh, of course, he may be permitted his little peccadilloes on commas and split infinitives and such—but these petty insistences on rightness are merely annoying to such great and all-knowing writers as me and Shaw and Hemingway. And his arbitrary chopping out of my priceless verbiage is inexcusable!"

Actually, the editor is the voice of conscience, the Jiminy Cricket immortalized by Walt Disney. The editor seeks errors of omission and commission, tries to find the food among the fluff, the facts amid the fancies. Then he must go on to make sure these facts are presented in such a way that the reader will be both interested and instructed. To that end, the ego of the author must on occasion be deflated. The story must come through without the breast-beating and brag, the tedious step-by-step recounting, the reminiscence and side issue.

All of us, when we write, tend to explore a subject like a squirrel explores a tree. We work up or down, going out each limb. This is fine—for a squirrel. But a surprising number of people merely want to know what kind of tree it is, how tall, and what can be seen from the top. All the branches are merely useful steps near the trunk—the outer ends are for the birds.

That's one of the technical editor's jobs—to keep the author going up the tree. If there is fruit on a limb, he picks it in passing, or marks it for future exploration. But the immediate job is to get to the top, and to take the reader along so he can share the view as well as the trip. The editor deletes the obvious and unnecessary to make the trip as short as possible.

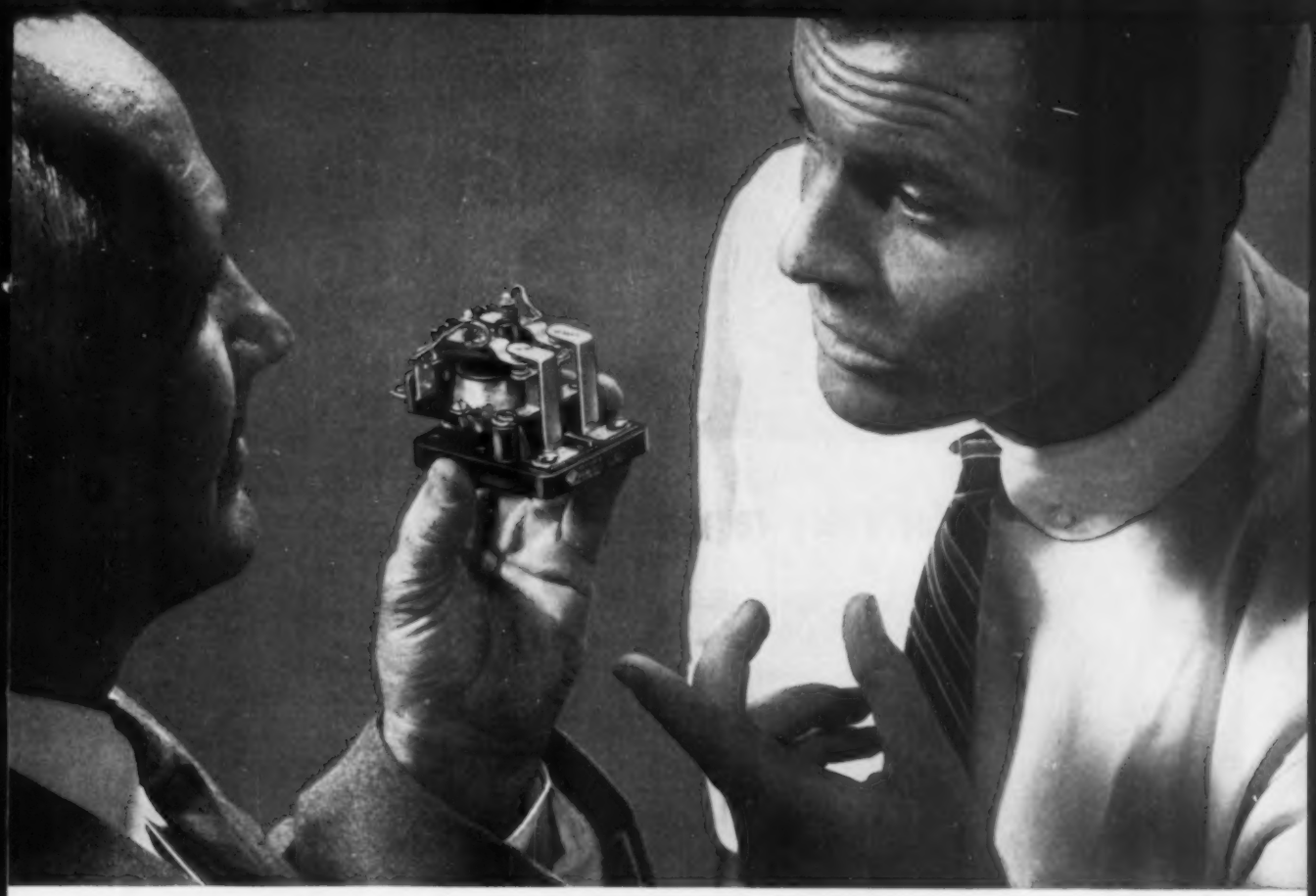
There is no intent here to usurp the author's authority or his hard-won knowledge, simply to select from it what the editor feels most readers want to know *right now*. There will of course be some readers who want more detail, some who won't want as much; if the editor has done his job well, the two groups will about balance. Some authors contend that no editor can know how much readers want to hear about his specialty; he is the expert and the judge. *He is the expert, but no judge;* any enthusiast is a poor arbiter of how much his auditors can take. The editor may be, too, but his is usually not a solo role; his work is checked by two or three other editors before it appears in print. Thus the author who objects to an editor's work is actually objecting to the decision of a jury—a jury of specialists who spend their time learning what the reader wants to know and how to reach him, just as the author has spent his time learning his subject.

Exact phrasing is always a subject for debate, even among the jury of editors. There is no question that rephrasing for simplicity sometimes destroys fine nuances of meaning. There is also no question that the nuances are often so fine they are undetectable. This is particularly true when the author goes in for specialty wording—latinizations, pompous phraseology, allusions to other sources unknown to the reader.

It is the good editor's prime job to tell the author's story in simple,

(Continued on page 145)

"To whom it may concern . . . we doubt if anyone can grace a drawing board as neatly as the bearer . . . and fall asleep while doing it . . ."



HERE'S WHY P&B's PR POWER RELAY IS PREFERRED

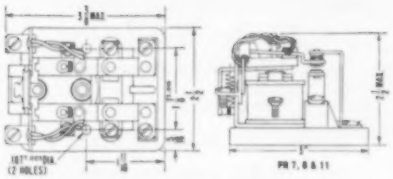
for high current/voltage switching

HEAVY DUTY construction means long-term dependability when switching up to 20 amperes (double break contacts). Here is a ruggedly built relay, packed with high quality features, yet economically priced.

The PR's full floating movable contact carrier, for example, provides excellent contact pressure and ample wipe for self-cleaning contact action. The coil is centrifugally impregnated with top-grade varnish to eliminate moisture traps.

Contact arrangements up to DPDT are available. The PR has been adapted for printed circuitry and heavy duty plug-in applications.

All standard AC actuated PR relays may carry the UL and Canadian Standards Association seals of approval. Write or call for complete information.



GENERAL SPECIFICATIONS:
Breakdown Voltage: 1500 volts rms min. between all elements and ground.
Ambient Temperature: DC: —55° to +85°C.
AC: —55° to +55°C.
Terminals: Heavy duty screw type. Standard printed circuit pins or plug-in on request.
Enclosures: PR dust cover.

CONTACTS:
Arrangements: Up to 2 Form C (DPDT).
Material: 5/16" dia. silver or silver cadmium oxide. (Others available)
Load: Single break: 15 amps; Double break: 20 amps at 115 volts 60 cycle AC resistive.

AUXILIARY CONTACTS:
Arrangements: 1 Form A, B or C.
Material: 3/16" diameter silver
Rating: 5 amps at 115 volts 60 cycle AC resistive.

COILS:
Resistance: 64,000 ohms maximum.
Power: 1.8 watts DC; 9.8 volt-amps AC.
Duty: Continuous AC or DC (DC coils will withstand 10 watts at 25°C).
Insulation: Centrifugally impregnated with high quality varnish.
Mountings: 2 holes .187" diameter 1⅞" o.c.

PR Relays Approved By Underwriters' Laboratories and Canadian Standards Association

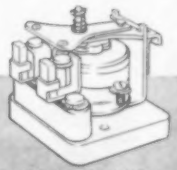
Type	Contact Arrangement*	Type	Contact Arrangement*
PR1AY	SPST-NO	PR5AY	SPDT
PR2AY	SPST-NC	PR7AY	DPST-NO
PR3AY	SPDT-NO-DM	PR8AY	DPST-NC
PR4AY	SPDT-NC-DB	PR11AY	DPDT

These relays are available in any of the following operating voltages: 6, 12, 24, 48, 115, 208, 230, or 440 volts 50/60 cycles AC.

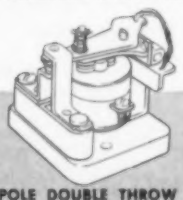
The contacts are rated at: 13 amps, 115 volts AC. 6.5 amps, 230 volts AC. 1 hp for 115 or 230 volt AC motors. Any relays deviating electrically or physically from these standard models will not carry U/L or CSA approval.

*Read: NO normally open, NC normally closed, DB double break, DM double make.

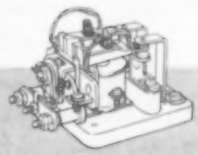
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



PR RELAY WITH MAGNETIC BLOW-OUTS
Models PR3 and PR7 can be supplied with alnico magnets to suppress arcs on DC loads over 1200 watts.



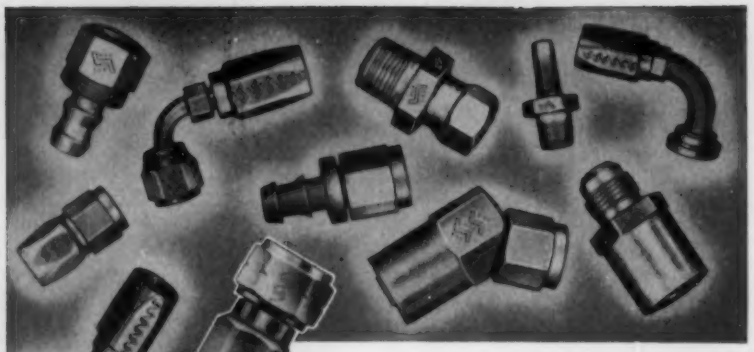
SINGLE POLE DOUBLE THROW VERSION
PR 5 (SPDT) has all the heavy-duty features of other models in this series.



PR WITH AUXILIARY CONTACTS
All PR models can be equipped with auxilliary contacts in 1 Form A, B, or C arrangements.

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY



for every requirement

STRATOFLEX HOSE & FITTINGS

- Fuel Lines • Hydraulic Systems
- LP-Gas Lines • Air Brakes
- Lubrication Systems • Water
- Coolants • Refrigerants

Made in a wide variety of sizes and types for hundreds of commercial and industrial uses, Stratoflex detachable and reusable fittings simplify maintenance and assure leak-proof connections under extreme temperature variations. Stratoflex hose provides the flexibility, small bend radii and durability essential for dependable service.

For detailed information, write for industrial catalog.

SF7-8

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Full House!

...a setko self-locking set screw for every problem!

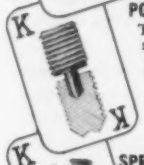
... And, every Setko Self-Locking set screw is an *ace* performer! Each one depends on a specific design principle to lock fast.

They provide positive locking action ... speed assembly and cut costs by utilizing standard driving techniques ... don't require special tapping. All are available in regular points, patented Nu-Cup point, and standard sizes and threads. With the Setko System, they can be hopper-fed in sizes as small as #2 (.086" x 1/8").

ZIP-GRIP® SET SCREWS
Exclusive Contra-Thrust action locks at any point. Solves problems of loosening due to wear, clearance in the thread, or vibration. Can be re-used.

OFFSET SET SCREWS
When driven, two offset edges in threaded portion exert powerful spring pressure. Not affected by extreme variations in tapped holes.

CREST-LOK SET SCREWS
New, original design doesn't require precise tapping. Can be re-used repeatedly. Amount of lock can be altered by changing tap drill size.



POINT-LOK SET SCREWS
This design ends top-screw loosening on two-screw applications. Lower screw can be locked with Point-Lok without disturbing original setting. Can be re-used.

SPRED-LOK® SET SCREWS
This design is for soft metal applications. Top is "spread" slightly to take up "flow" of soft metal. Can be re-used.

FREE, New "SELECTOR CHART" of Self-Locking Set Screws

Illustrates and describes complete range of Setko locking actions, points, metals, combinations, etc. WRITE TODAY... Also ask for our complete catalog No. 23.

Set Screw & Mfg. Co.
153 Main Street, Bartlett, Illinois

straightforward language, so it can be understood by as many readers as possible. If the author has an interesting and readable style, the editor shouldn't destroy it. He won't, if he's capable. But in most cases the technical writer is primarily dealing in exposition of technology and has neither special skill nor training in writing, so his writing has no special style, regardless of what he may think.

The ability to write is not nearly as much a gift of the Magi as it is an acquired skill. The editor practices it more consistently, is selected for his ability to write in the first place, is given special training and continual brushing-up in most publishing organizations. He also has access to studies and reports of reader reaction that show which presentation techniques are most acceptable to readers. He knows, for example, that Confucius was right; it is better to chart, tabulate and picture information than to keep it in words. And the elaborate, smoothly flowing phraseology doesn't hold a candle to the broken-up, properly titled series of steps or "takes," each devised to tell its own story as quickly and clearly as possible.

Lastly, the engineering writer does two things that no other writer does. He consistently starts his paper and each paragraph with known and agreed-upon information. Then he adds the new or the nuance further on. This is in sharp contrast to anything else informational to which the reader is exposed. His newspapers, general magazines and the like give him the news first, then fill in—the

(Continued on page 146)

"You wander around too much, Dugan!"

A NEW APPROACH TO MACHINE PROCESS CONTROL

Step Sequencing

the new Eagle Step Switch

use any type of time or sensing device to advance the Eagle Step Switch

PUSH BUTTON
LIMIT SWITCH
INTERVAL TIMER
PRESSURE CHANGE
LEVEL CONTROL

operate a multiplicity of load circuits in any combination up to 19 circuits

This new Eagle Step Switch also provides:

1 SEQUENCING INTERLOCK when used with multiple indexing circuits.

2 10 AMP SWITCH CONTACTS control load switches direct—no need for load relays.

3 MECHANICAL CIRCUIT INTERLOCK by cam action—eliminates interlocking relays.

4 115 VOLT COIL operates direct on AC with heavy duty ratchet mechanism—insures long life.

EAGLE TIMERS SAVE TIME . . . SAVE MONEY
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The New WATLOW FIREROD® CARTRIDGE HEATER

a new standard in watts densities ...and longer operating life!

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The FIREROD is available in lengths from ¾" to 12", in diameters of ⅜", ½", and ⅝".

FREE ILLUSTRATED LITERATURE *describes operation data, tests, styles, etc. Write for your copy today!*

WATLOW

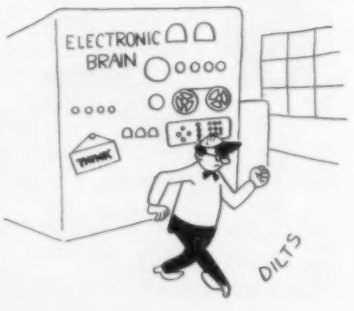
ELECTRIC MANUFACTURING CO.
1392 Ferguson Avenue
Saint Louis 14, Missouri

same "flashback" technique the movies use. The good editor does this, too. He inverts the article so the summary and conclusions are at the beginning, so the reader can decide at once whether the article will add anything to his knowledge, whether it will be worth his time in new information.

Putting salient results first will often snare a reader who otherwise wouldn't bother. His training teaches him to plow through anything to get the facts; his instincts and common habits, however, are all the other way. So is his natural tendency to avoid reading unless he's intrigued or forced. Too often, instinct wins, and an author with a message shouts it in the desert. There just isn't any point in doing the third act spectacularly well if the audience went home at the end of the first. That's the editor's key job—to speed up the first act and make it so interesting the audience stays through the end of the show.

We haven't said much about spelling, punctuation, simple arithmetic, and the like. These are things the editor does, of course, just as he supervises drawings, photo retouching, and organization of text and illustration for maximum impact and readability. But these are expected and acknowledged functions, so scarcely worth mention; the others are not so often recognized.

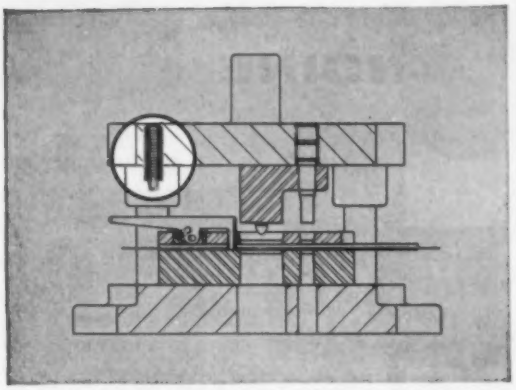
Just to prove it isn't only the contributor who suffers at the hands of the editor, I will admit that each editorial I write—as well as this essay—passes under the eagle-eyed scrutiny of at least two editors. They work for me, according to the table of organization, but they forget that when they go to work on my copy. And they save me endless embarrassment, even after 35 years of writing, by picking up and correcting mistakes that otherwise would get through to you. —EJT



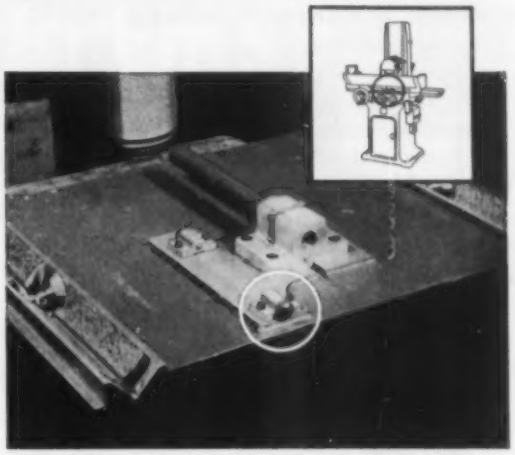
Practical Design Tips

Number 2 of a series.

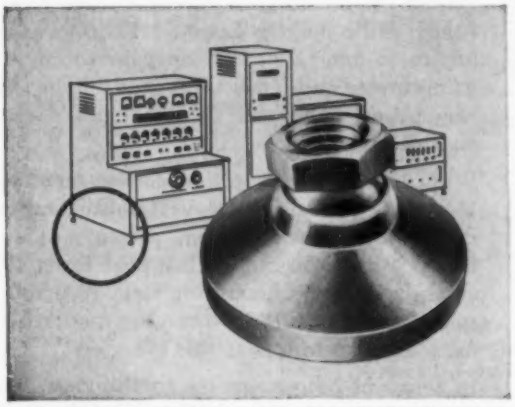
Substituting simple, off-the-shelf Vlier Tooling Accessories for complicated, custom-made devices in both tooling and original equipment applications can result in important savings. Why not put them to work in your plant?



TO STOP SMASHING DIE STOPS, substitute a Vlier Spring Plunger for the usual square-head screw. The plunger actuates the automatic stop perfectly and, unlike the screw, never needs adjusting no matter how many times the die is resharpened. Available in four models: 50 sizes.



TO CUSHION SHOCK as the bed traverses, this surface grinder manufacturer uses two Vlier Spring Stops, reducing wear and tear on the machine. These clever, spring-loaded devices, ordinarily used on fixtures where the absence of side walls prevents the use of spring plungers, are now available in three standard sizes: 3 end pressures. Special sizes made to quantity orders.



TO LEVEL MACHINE TOOLS, electronic racks, benches, etc., use the *standard* Vlier leveling pad. The pad swivels to 7½° each side of the center line; adjusts automatically to uneven surfaces. Unique ball-joint design distributes weight over entire pad surface.

TO GET NEW IDEAS on how to save with Vlier Tooling Accessories, send for new 28-page booklet "Typical Applications of Vlier Tooling Accessories." It suggests dozens of ways to use these time-savers in both tooling and original equipment applications. Write for your copy today.

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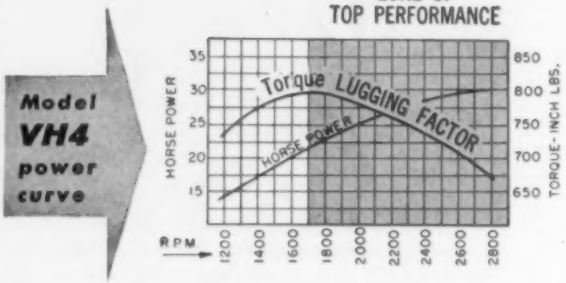
WISCONSIN

heavy-duty Air-Cooled

ENGINE



It's "heavy-duty" in fact as well as in name. It's built for rugged field service under *your conditions*, no matter how tough they may be.

One of the outstanding characteristics of this engine is its bulldog LUGGING FACTOR . . . the ability to *hang on* and keep your equipment going under suddenly increased loads that would most likely stall other engines of comparable piston displacement.

With a 107.7 cu. in. piston displacement the V-type 4-cylinder Model VH4D "Wisconsin" delivers 30 hp. at 2800 rpm. with a torque of 675 inch-lbs. Working against peak loads, this engine will keep on slugging away against an rpm. slowdown from 2800 to 1700 rpm., reaching maximum torque at this low speed.

In terms of *power service* to the user, this simply means that your Wisconsin Engine is designed to provide dependable load-holding power *at low engine speeds*. This, in turn, means fewer shutdowns, less wear and tear, more usable power and more versatile performance for your dollar investment.

The high LUGGING FACTOR is one of the basic characteristics that makes Wisconsin Engines worth more . . . one of the reasons why it pays to specify "WISCONSIN" for your equipment.

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DESIGN ABSTRACTS

Wet & Dry Clutches

Two papers presented at the SAE National Farm, Construction and Industrial Machinery Meeting, Milwaukee, Sept 8-11, evaluated effect of engine operating conditions on torque characteristics of dry-type clutches (SAE paper 76A, Prosek and Barber, International Harvester Co) and engagement characteristics of wet-type clutches (SAE paper 76B, L P Ludwig, Twin Disc Clutch Co).

Obtainable from SAE, 485 Lexington Ave, New York 17.

Cushioned Gear Drives

Devices surveyed cover the full power range, from very light to heavy duty. Resilent materials and various types of spring designs are discussed.

"Cushioned Gear Drives," R Waring-Brown, Mechanical World and Engineering Record, Sept '58, 31 King St, W 3, Manchester, England.

Sleeve Bearing Life

Results of a study of sleeve bearing design at Franklin Institute, Philadelphia, for the Cast Bronze Bearing Institute (Non-ferrous Founders' Society), 1604 Chicago Ave, Evanston, Ill, were discussed by Dr. Dudley Fuller of Columbia University at a recent CBBI meeting. Role of lubricant, in particular, was studied closely. Study is also to be the subject of a technical manual on cast bronze sleeve bearings for design engineers, now in preparation.

Organic Finishes

Most of the commonly used finishes, along with the newer ones, are included in this detailed discussion of coatings—in which the emphasis is on those for high-temperature service and abrasion protection. A history of organic finishes is given, including dates, origins, materials, uses.

Both the synthetic resins in use today are listed and the vehicles commonly used with them described. Advantages and disadvantages, selection factors, surface textures and

(Continued on page 153)

GEAR PROBLEMS?

—check with

FAIRFIELD!

GEAR PERFORMANCE to match the ever-increasing power and speed of modern machines is a Fairfield specialty. This is possible because Fairfield has long held a position of leadership in utilizing the most advanced methods, equipment, and techniques for producing better gears. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of the nation's leading machinery builders.

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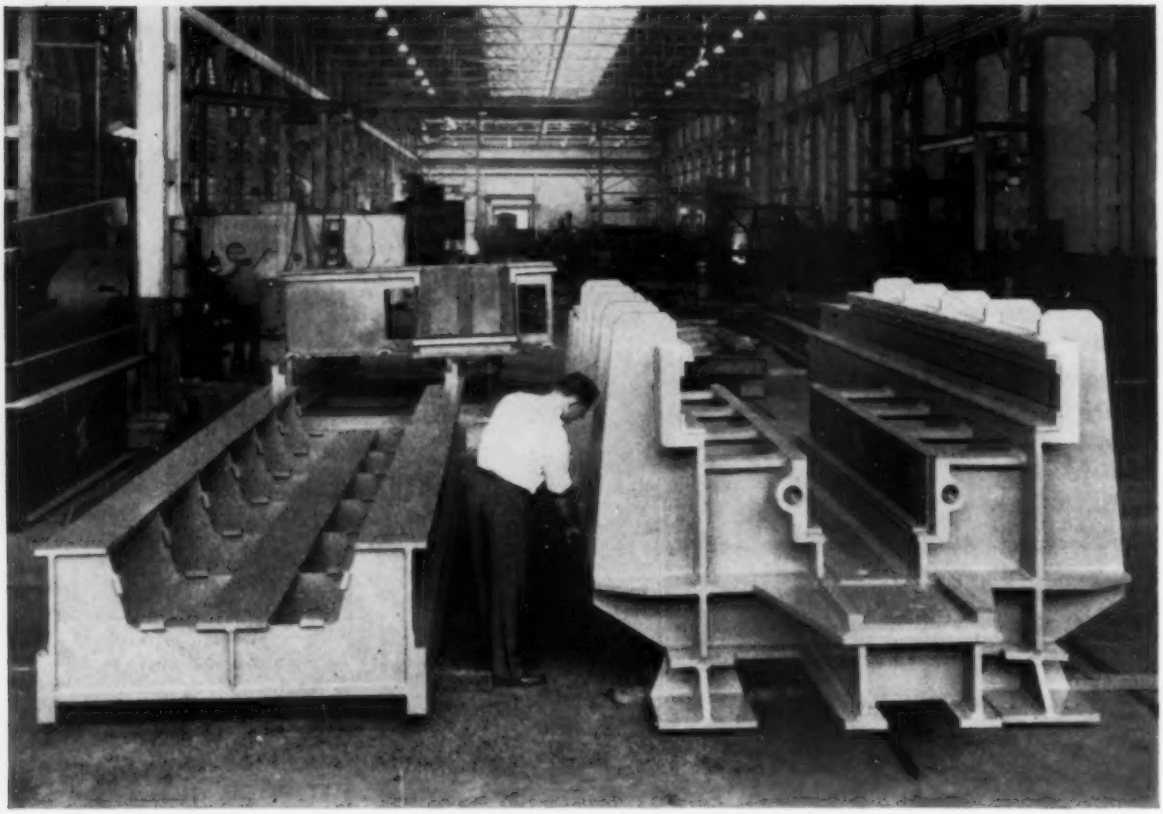
STEEL-WELD FABRICATION . . .



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Out of National's research laboratories come new advances every day. See your National Representative about new products and applications. He can keep you posted on the full line of PHENOLITE Laminated Plastic, Vulcanized Fibre and National Nylon for electronic applications across-the-board. In the meantime, write for our new "PHENOLITE Copper Clad Data" folder. Address Dept. H-11.

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TYPICAL TEST VALUES ON COPPER CLAD PHENOLITE

GRADE	PROPERTIES OF BASE MATERIAL					COPPER CLAD PROPERTIES			RELATIVE COST
	Dielectric Constant	Dissipation Factor	Moisture Absorption	Flexural Strength	Maximum Operating Temperature	Copper Bond Strength		Hot Solder Resistance	Surface Resistance	Based on XXXP on Arbitrary Scale of 1
	10^6 Cycles	10^6 Cycles	1/16", % 24 Hrs	Psi	Degree F	Pounds to Pull 1" Strip		Secs to Blister 1" Square > Greater Than	Megohms, Etched Reims Comb Pattern, 96 Hrs./35°C./90% RH	1/16" Thk. 1 Oz. Copper 1 Side
						1 Oz	2 Oz			
P-214-B-1	5.3	.040	2.20	18,000	250	8	11	>10@475°F	100,000	.81
XXP-209-G-1	4.6	.037	1.30	17,000	250	8	11	>10@475°F	200,000	.92
XXP-239-1 PHENOCLAD	4.2	.035	0.67	15,500	250	8	11	>10@475°F	200,000	.92
XXXP-219-C-1	4.5	.030	0.70	15,500	250	8	11	>10@475°F	500,000-1,000,000	1.00
XXXP-455-1	4.0	.026	0.55	23,500	250	8	11	>10@475°F	1,000,000-1,500,000	1.00
XXXP-470-1	3.7	.027	0.48	14,000	250	8	11	>10@475°F	300,000-500,000	1.00
N-1-852-1	3.3	.030	0.20	16,000	165	8	11	>10@450°F	2,000,000	2.69
G-5-813-1	6.8	.018	1.00	55,000	300	8	11	—	—	2.98
G-10-865-1	5.2	.012	0.13	60,000	250	10	15	>30@500°F	1,500,000-2,000,000	3.49
G-11-861-1	4.9	.015	0.17	60,000	300	10	15	>30@500°F	2,000,000	3.55

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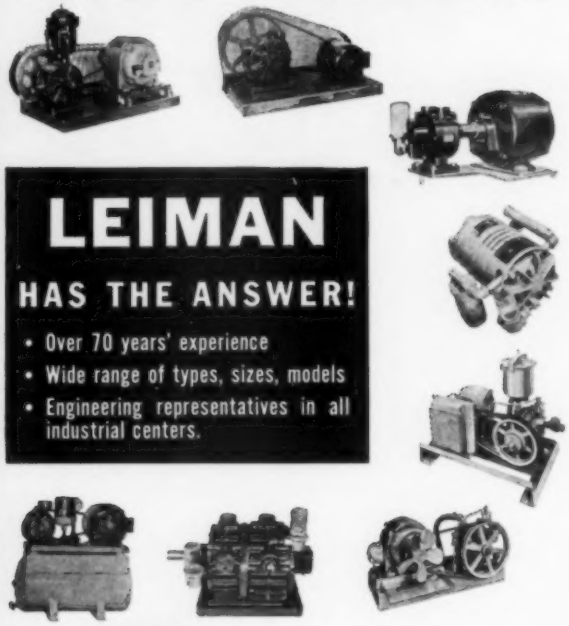
This Name Counts! WALL TUBE AND METAL PRODUCTS CO.

Wall Tube and Metal Products Co. manufactures a large variety of tubular specialties in a wide range of metals, in spiral lock-joint construction, open seam and protruding seams, either perforated or solid walls up to 6" OD. May we send you a copy of our new tubing catalog?

WALL TUBE & METAL PRODUCTS CO.
NEWPORT TENNESSEE

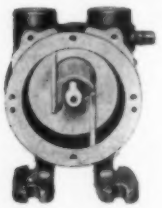
VACUUM PROBLEM?



LEIMAN HAS THE ANSWER!

- Over 70 years' experience
- Wide range of types, sizes, models
- Engineering representatives in all industrial centers.

4-WING TYPE. Vacuums to 20" Hg.; pressures to 15 psig.; volume to 162 cfm. Cast iron wings, hinged to pistons, maintain continuous sealed contact with the cast iron cylinder walls by centrifugal force.



2-WING TYPE Vacuums to 29.9" Hg.; pressures to 20 psig.; volume to 40.8 cfm. Automatic wing adjustor forces wear-resistant steel wings to cast iron cylinder walls, preventing sticking or binding, maintaining positive vacuum or pressure.

- **Consult Leiman engineers on any vacuum application**
- **Install Leiman Vacuum Pumps for "lifetime" dependability**

Vacuum operations are usually critical, requiring a steady, reliable source of rated vacuum. You get this with Leiman Rotary Vacuum Pumps because they are designed to take up their own wear. They have fewer moving parts—and all parts are precision-made of durable cast iron and steel (not composition) to maintain new pump efficiency for 10, 15 and 20 years, without maintenance except oiling.

High vacuum, high volume, small space

The simplified Leiman design provides larger air space, permitting use of smaller pumps, slower speeds, less horsepower. Operation is quiet.

Every pump tested!

Each individual Leiman Vacuum Pump is given a long test run before shipment to assure fully rated vacuum, pressure and c.f.m. capacity.

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WRITE for 16-page catalog, plus Application Book showing many "how-to-do-it" blueprints.

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Established 1887

LEIMAN Rotary Air and VACUUM PUMPS

colors, mechanical, electrical and thermal properties and characteristics are all included. Methods of application and surface preparation are discussed. Probable future developments in organic finishes are described.

"Modern Organic Finishes," Glaser and Bromstead (Midland Industrial Finishes Co); Plating, Oct '58, 445 Broad St, Newark 2, N J.

Survey of New Plastics

Recently introduced materials of many types are briefly discussed, with comments on properties, applications and sources of supply. Included are boron compounds, polyorymethylene, Teflon-bonded ceramic fibers, glass microspheres, sintered nylon, perfluorocarbon, chlorinated polyether, polyproplylene, polyethylene, diallyl phthalate, acrylics, polycarbonates, phenolics, reinforced plastics, silicones, epoxies, styrenes.

"New Materials—A Survey Paper," J H DuBois; SPI, 250 Park Ave, New York 17.

Flat Air Bearings

An investigation of air bearings being conducted at the Mechanical Engineering Research Laboratory, Glasgow, England, has developed some empirical data on the relationships for stiffness and lift in two sizes of bearings ($4\frac{1}{2} \times 1\frac{1}{2}$ in., $13\frac{1}{2}$ sq in.; 3×1 in., 6 sq in.). A supply pressure of 40 psi was used, with three air inlets in each test pad. Experimental equipment and test procedure are described and the effects of varying orifice diameter and set-back, supply pressure, orifice plug diameter discussed. Results obtained are reported under such headings as lift and load, stiffness, supply pressure and lift, required air flow, bearing size, set-back area. Curves, tables, equations and a typical design example are given.

"Design Data for Flat Air Bearings," H. L Wunsch; Metalworking Production, Sept 26, '58, 95, Farringdon St, London, E. C. 4, England.

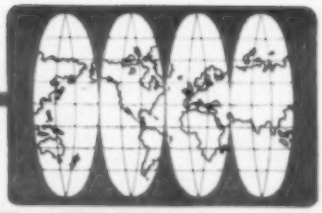
Ball and Roller Bearing Lubrication

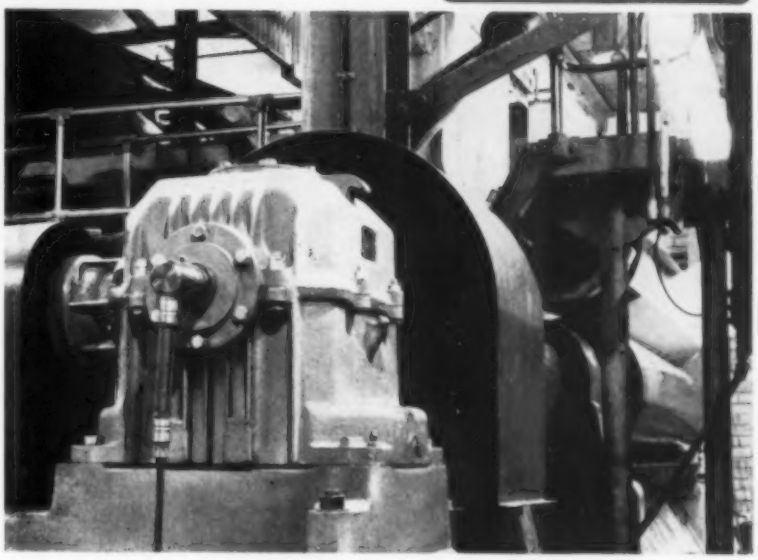
Theory, history and use of grease in rolling-element bearings is discussed. A review of testing procedures is included, and recent advances are described. A bibliography and "trouble-shooting" chart are provided.

"Ball and Roller Bearing Lubrication," Lubrication, Aug '58; Texas Co, 135 E 42nd St, New York 17.

DAVID BROWN

at work around the world





This Canadian installation is typical of the cooperative service of David Brown companies around the world. Write for details.

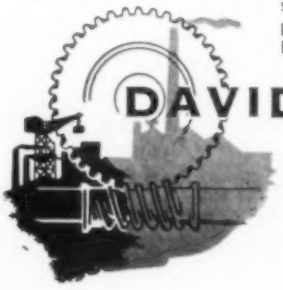
...HELPING TO SMOOTH THE WORK OF A SMOOTHING PRESS!

It always matters how you gear a new installation such as this smoothing press at Rolland Paper Company's St. Jerome, Quebec mill. The gear in this case is a David Brown 17" spiral bevel unit — one of many used on the new machines by Millspaugh, famous for paper industry equipment.

This modern right angle drive installation can run continuously, hour after hour. Its 4 to 1 ratio will transmit 200 hp at 2,000 rpm pinion speed — with a high (98%) efficiency. These compact and sturdy spiral bevel gears are made in sizes from 6" to 60" by David Brown Industries.

The popular fan-cooled Radicons are also widely used in the paper industry — specified by original equipment manufacturers. They have learned Radicon's ability to withstand extremes of temperature, dust, dirt and rain — with initial low cost, and low maintenance.

Immediate delivery on Radicons 3" to 14" all standard ratios from 5:1 to 60:1. Radicon complete drives supplied by all authorized David Brown factory branches and distributors.



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Since the dawn of the Automotive Age, National has supplied vital oil seals for the wheels, power trains, engines and accessories of cars, trucks, buses and off-highway vehicles. National is proud of this record, proud to be a part of our nation's greatest industry, proud of the faith Detroit places in the products we make.

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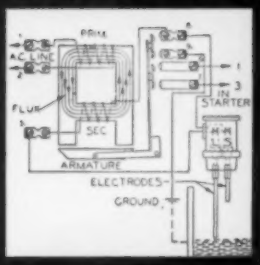
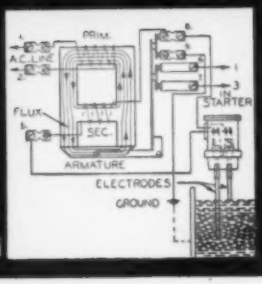
LIQUID LEVEL CONTROL
with the
B/W RELAY





Type LH Relay for Pump Down Control

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The B W system of liquid level control consists of a transformer type induction relay and a holder for one or two electrodes, depending on the desired operation and the type of relay used. The relay incorporates a primary or line voltage coil connected to a permanent source of alternating current, and a secondary or electrode circuit coil connected to the electrodes immersed in the liquid being controlled. Energizing the primary coil causes an induced voltage in the secondary coil; thus the secondary coil is never connected to the power line.

LIQUID IS ELECTRICAL CONDUCTOR

The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

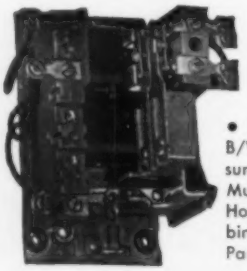
FOR PUMP UP and PUMP DOWN APPLICATIONS, SIGNALS and ALARMS

B/W relays are designed for either pump up or pump down operation. In addition, by using a single electrode they are well suited for signal and alarm applications.

NO MOVING PARTS

The complete absence of moving parts in the liquid insures long and trouble-free performance. Because of the very low current in the secondary circuit these relays are ideal for many switching jobs outside of the liquid level field.

Consult our engineering department on any special control applications.



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NEW BOOKS

Unconventional Electrical Power Sources—Parts I and II

A L BETTS, P A McCOLLUM. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½x11: Part 1 (PB 131 411), 74 pp; Part II (PB 131 218), 75 pp, paper.

An excellent review of present status and probable future development of novel means for conversion of heat, chemical, mechanical and solar energy into electrical power, this 2-part survey is well worth having and reading. It was prepared by engineers at Oklahoma Institute of Technology for Air Force R & D Command. Part I covers full range of devices; Part II is a later, and more detailed study of several of most promising ones (thermocouples, fuel cells, solar batteries, ion exchange membranes, and oscillating electromagnetic generators).

Introduction to Work Study

Published by International Labor Office, 349 pp, 7 x 11. $3.50.

This book was written in the first place for persons attending courses in work study run by International Labor Office technical assistance missions and to help provide lecture material for the missions themselves and the staffs of national productivity centers in countries receiving technical assistance from the ILO. The book describes basic techniques of work study, giving examples of the applications of each. It is divided into four parts: Productivity and work study, method study, work measurement, appendices.

Human Factors in the Design of Systems

H W SINAIKO and E P BUCKLEY. Available from Office of Technical Services, Washington 25, DC. 49 pp, 8½ x 11. $1.50.

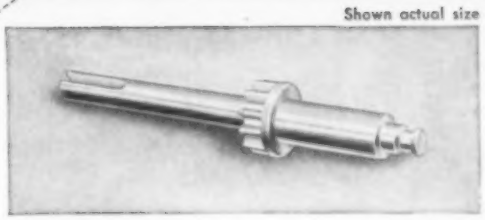
In much the same way that handbooks are used to describe mechanical, electrical, or electronic components, this report is intended for the designer of systems incorporating men as operators, maintainers, or monitors of machines.

The report covers five things: 1) the human component and the process of

(Continued on page 159)

here's PROOF of how the GRC method cuts the cost of small parts...

Shown actual size



Take, for example, this part which previously had been produced 3 different ways . . .

METHOD A
ASSEMBLY OF 2 SCREW MACHINE PARTS
Screw Machine Part
Mill Slot
Machined Extrusion
Assembly
4 Production Steps
+ 3 inspections

METHOD B
CONVENTIONAL DIE CAST AND MACHINED PART
As Cast
Trimmed
Machining for Undercut and Sizing of Diameters
3 Production Steps
+ 2 inspections

the GRC method
AUTOMATICALLY DIE CAST
1 Production Step
only one inspection

Now take a look at these comparative figures . . .

	Purchased Material	Cost/M	Scrap Generation	Cost in lots of 100 M	500 M
Method A	Brass	$30	30%	$70/M	$69/M
Method B	Zinc Alloy	$3.82	5%	$30/M	$28/M
GRC Method	Zinc Alloy	$3.64	None	$15/M	$11.50/M

Check the chart; you'll see clear proof of how GRC's DIE CASTING METHOD offers substantial savings on your small parts. The Gries Method delivers parts of high uniformity, with close tolerances . . . ready for use. Assembly and most other secondary operations are eliminated.
Write, wire, phone NOW for GRC's bulletin "Small Die Castings Exclusively"; send prints for quotation.

MAXIMUM SIZE 1¾" long, ½ oz. NO MINIMUM

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World's Foremost Producer of Small Die Castings
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A painter prompted a new look

When one of our maintenance department painters was redecorating the treasurer's office, he asked about U.S. Savings Bonds. "If I could buy these Bonds on installments," he said, "and you could take my payments out before I got my paycheck, I'd hardly miss it."

Our treasurer explained that the Payroll Savings Plan does exactly that and gave the painter an application card. But the matter didn't end there, for our painter had given *us* something, too: an idea that helped to put real color into our plan.

He made us realize that if he was unfamiliar with this plan, many others must be in exactly the same position.

Our State Savings Bond Director helped us pass the word. Under his direction, we set up a company-wide campaign that gave the whole Payroll Savings story to every person in the Company. Within a few days we had the best employee participation we've had since the mid-forties.

People are quick to take advantage of this sound, automatic way to save money. Today there are more payroll savers than ever before in peacetime. Look up your State Director in the phone book or write: Savings Bonds Division, U.S. Treasury Department, Washington, D.C.

PRODUCT ENGINEERING

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designing systems; 2) a summary of the characteristics of the human component with implications for design engineering; 3) the effects of human characteristics upon engineering tests and system evaluations; 4) an annotated reading list; 5) a checklist of human factors considerations in system design and evaluation.

Differential Equations

FOREST RAY MOULTON, PhD, ScD. Published by Dover Publications Inc, New York City. 8 x 5, 395 pp. $2.

This volume presents a complete treatment of all the processes for solving differential equations that have wide applicability. Its contents are a part of the lectures on differential equations given by the author at the University of Chicago for more than 20 yr. These lectures from time to time, besides the subjects treated here, also included partial differential equations, and the solutions of ordinary linear and nonlinear differential equations in the neighborhood of their singular points.

Designing Parts for Cold and Hot Heading

Published by Industrial Fasteners Institute, 1517 Terminal Tower, Cleveland 13. 7 x 10¼, 95 pp. $2.00

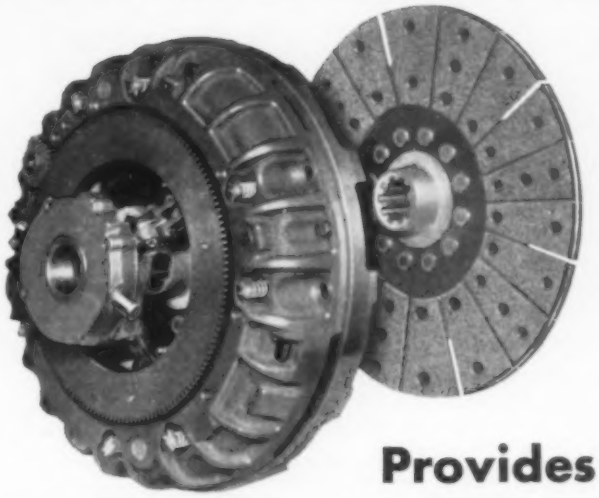
This book is an example of what a frustrated copywriter can do to a legitimate guide to designers. There is little excuse for what should be advertising copy to appear in the book itself. The $2 price tag is fair for the 20

(Continued on page 161)

"Brilliant suggestion, Fred. I only wish you were in the sales department so we could get a raise through for you!"

ROCKFORD

NEW MORLIFE® CLUTCH FACING



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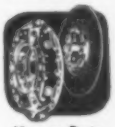
Smooth engagement and disengagement is a distinguishing quality of this NEW metal-base Morlife clutch facing. It provides the extra torque required by heavy-duty highway vehicles and off-highway equipment. Unusual heat dissipation and resistance to wear insure longer life—with less frequent adjustments and replacements. It will pay you to give *your* products these competitive advantages of ROCKFORD Morlife Clutches.

Small Spring Loaded

Automotive Spring Loaded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Oil or Dry Multiple Disc

Heavy Duty Over Center

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Speed Reducers

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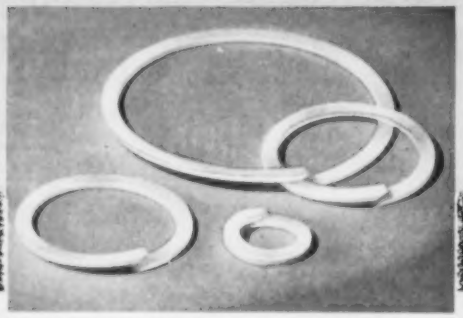

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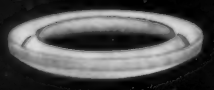
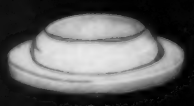


Style 410 U Cups and Blocked Vees



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Halogen cylinder packing is known for operating successfully and efficiently over the widest temperature and pressure ranges . . . because they are "MEMORIZED".

This is an EXCLUSIVE process which makes the packing lip "remember" the size of the rod or cylinder . . . and keeps it in sealing position, regardless of temperature variations.

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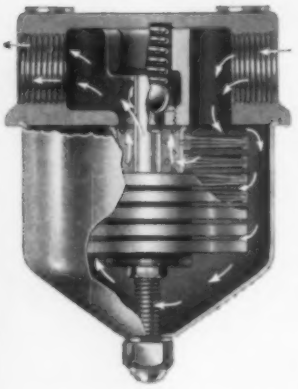

• For the first time, the cleanability and long life of an all metal filter has been combined with extremely small particle removal. The Air-Maze liquid filter is available in many degrees of filtration, down to 98% removal of 10 microns and larger. Constructed of specially processed wire mesh, filtering media is arranged in form of multiple discs which afford over six times more effective area than the same size cylinders. Built-in relief valve optional. Sizes from 1.7 to 720 gpm. Write for bulletin LFC-556. **AIR-MAZE CORPORATION,** Cleveland 28, Ohio.

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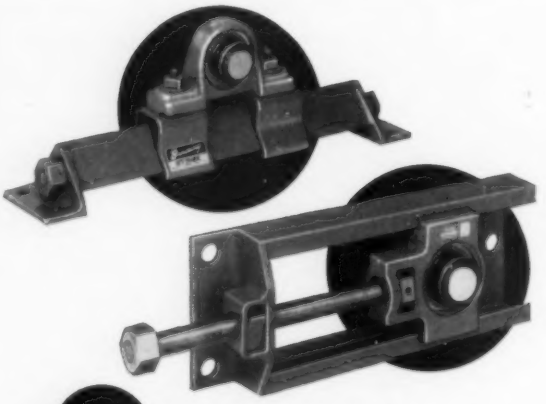


Browning **BEARING UNITS are rugged, compact, light**

In Browning pillow blocks, flange blocks and take-up units are combined all the advantages of modern anti-friction bearings . . . plus Browning's exclusive *unbreakable malleable* housings, far stronger than ordinary castings. Power transmission experts find these units unusually rugged and dependable, specifying them whenever the application demands 1) greater strength, 2) less space, 3) less weight, 4) trouble-free service, 5) longer life. Investigate now! Write for free descriptive catalog BU-101.

Browning Manufacturing Company, Maysville, Kentucky

Browning POWER TRANSMISSION EQUIPMENT

pages of design content; but the time wasted in wading through the rest of the book seriously impairs its value.

Scattered through the book are 60 case histories to illustrate what cold heading can do. But most of them repeat the same comparison of cold-headed parts with their more expensive screw machine counterparts. The first three pages of text repeat the message—lower cost—eighteen times. In spite of its presentation, this book actually contains design information. It is unfortunate that it is so well disguised.

Research on Liquid Metals and Salts as Power Transmission Fluids

RICHARD H. BLACKMER. Available from Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10, 93 pp. $2.50.

The eutectic alloy of sodium (23% by weight) and potassium (77% by weight), known as NaK-77, has been determined from a technical survey of liquid metals and salts as the most feasible *liquid* known hydraulic-system applications from 10 to 1000 F. A single-cylinder test pump in an inert atmosphere glove-box has pumped NaK-77 up to 3600 psi at 100 F and up to 2000 psi at 1000 F. A total of about 100,000 cycles at 1 cps and an average pressure of 1500 psi have been accumulated. Results of literature survey, consultation, and laboratory tests are included in this report.

Operational Mathematics

RUEL V. CHURCHILL. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36. 9 x 6, 337 pp. $7.

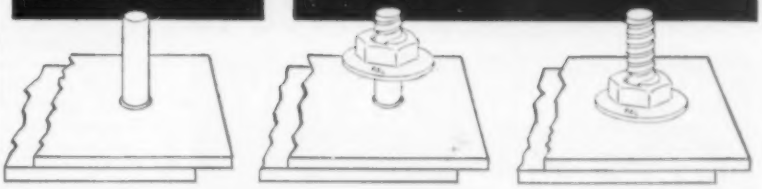
This textbook on the theory and applications of Laplace transforms and other integral transforms was written for students of mathematics, engineering, physics, and other sciences, whose mathematical background has reached the level of advanced calculus. It gives a sound mathematical treatment which will give students not only a working knowledge of operational mathematics, but also a clear understanding of how, when, and why integral transformations can be used.

Applications are chiefly to problems in engineering and physics that involve differential equations, with

(Continued on page 163)

How an UNTHREADED stud, rod, wire or rivet...

...automatically becomes a strong THREADED member for tight assembly--



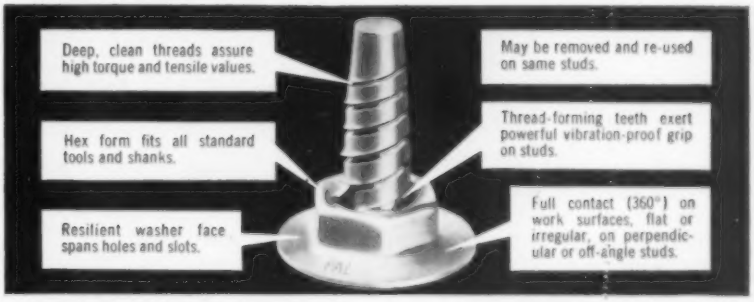
—when fastened with low-cost, high-speed

PALNUT® SELF-THREADING LOCK NUTS

PALNUT Self-threading Lock Nuts are spring-tempered steel fasteners with a special thread-forming design. Fastening operation forms threads while tightening. Effective on zinc, aluminum, steel or brass. Assembly is easy and fast using standard tools—extra fast using PALNUT magnetized wrenches. Hold tight under vibration whether seated or unseated.

TYPE ST--WASHER BASE

This one-piece Self-threading nut performs functions of ordinary nut, lockwasher and flat washer. Available in several base diameters; also with bonded-in plastisol compound to seal out water and dirt. Sizes for 1/4", 5/16" and 1/4" dia. unthreaded studs and rod.


Deep, clean threads assure high torque and tensile values.
Hex form fits all standard tools and shanks.
Resilient washer face spans holes and slots.
May be removed and re-used on same studs.
Thread-forming teeth exert powerful vibration-proof grip on studs.
Full contact (360°) on work surfaces, flat or irregular, on perpendicular or off-angle studs.

TYPE RST-- REGULAR HEX

This compact Self-threading nut requires shorter stud or rod space, less seating area. Costs less, assembles as fast as push-on nuts, parts stay tighter, can be removed and re-used. May be driven with internal wrench. Sizes for 1/4", 5/32" and 3/16" dia. unthreaded studs and rod.

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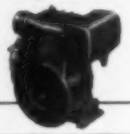

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Max. BHP @ 3600 RPM	9.6 BHP	9.2 BHP	9.0 BHP
Cu. In. Displacement	25 Cu. In.	23 Cu. In.	23 Cu. In.
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Max. BMEP @ 9 BHP @ 3600 RPM	79.2 P.S.I.	86.1 P.S.I.	86.1 P.S.I.
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emphasis on boundary value problems in partial differential equations. Problems in vibrating mechanical systems, electric circuits, and servomechanisms, involving systems of ordinary differential equations, are given considerable attention. The physical problems are kept on a fairly elementary level.

Principles of Noise

J J FREEMAN. Published by John Wiley & Sons, Inc, New York City. 9½ x 6, 299 pp. $9.25.

This book acquaints the reader with enough of the principles, facts, and techniques used in noise analysis to take him to the level where he can read the literature with enough ease to use it as a professional tool.

The author deals with such topics as probability, stationary random processes and their transformation, power spectra, noise and factors of various circuits. He explains the relationship of one concept to another, why each concept was created, what its usefulness is, and what its limitations are.

Design Data for O-rings and Similar Elastic Seals

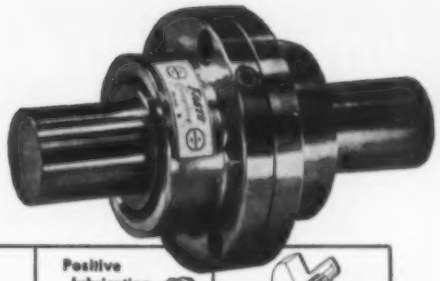
GEORGE E TREPUS. Available from Office of Technical Services, US Dept of Commerce, Washington 25, DC. 8 x 10, 106 pp. $3.

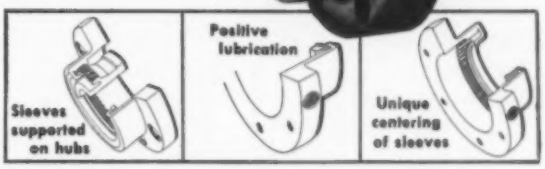
This study discusses the relationship between physical properties of seal materials and sealing efficiency so materials can be fully utilized in seal design. The literature survey on O-rings and seal design has been continued. Commercially available poly-

(Continued on page 165)

"Looks really great on your drawing board, Flinn—now, if your drawing board could only fly!"

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

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THE ORIGINAL *FAST'S Couplings*

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CAN YOU USE THESE FEATURES IN

VARIABLE SPEED DRIVES AND DIFFERENTIAL TRANSMISSIONS?

- **Full torque at zero speed**
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- **Shockless starts • Fully reversing**
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Designed and produced by Stratos, the family of SPECON drives and transmissions is shown in a new free booklet — including capacity charts and output speed regulation.

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Stratos Industrial Products Branch #42, Route 109, West Babylon, N.Y.

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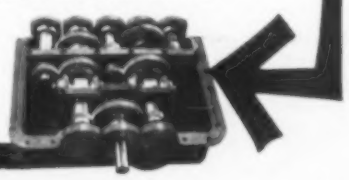
The differential gearing of SPECON mechanical transmissions and electrical drives is available where gear boxes alone are needed. Special units for specific requirements are a SPECON specialty — standard sizes up to 75 hp are also available.



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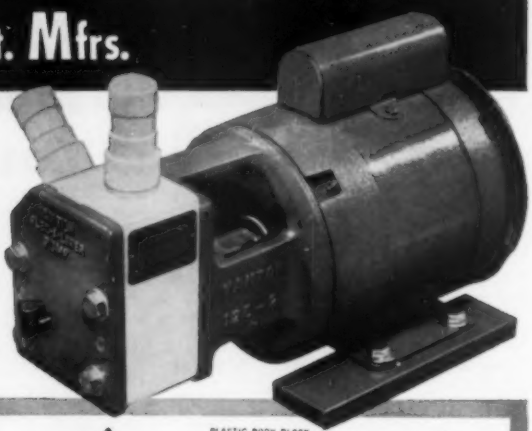
- Non-contaminating
- Non-agitating
- Operates wet or dry



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This new Vanton pump is designed to provide the equipment manufacturer with a low-cost, versatile, simple yet carefully engineered unit, problem-free with minimum maintenance. Construction materials at present available include PVC, high-temperature polyethylene, Teflon*, Buna N, bakelite, or stainless steel, in capacities from 1/3-10GPM. For information, write for BULLETIN CC10.1.

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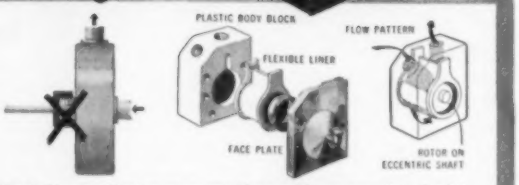

Basic Vanton Design removes the problems associated with stuffing boxes and shaft seals by eliminating the seals themselves. All fluid moves in a channel formed by the outside of a flexible rubber or synthetic liner, and the inside of a molded plastic or stainless block. Liner flanges are sealed as shown against the body block sides by end plates. Pumping mechanism is rotor mounted on eccentric shaft inside liner. At each revolution it creates a progressive squeegee action on the fluid trapped between liner and housing.

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DIVISION OF COOPER ALLOY CORP.

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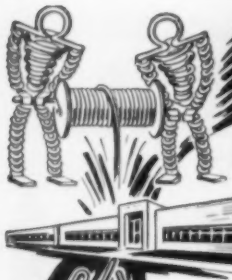

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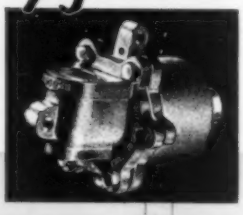

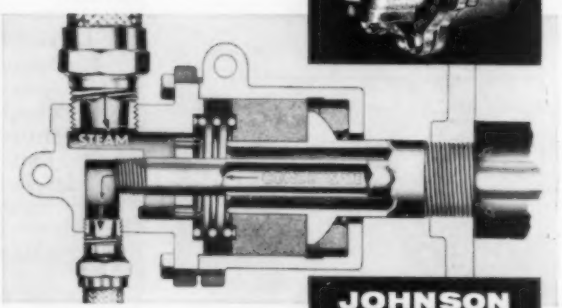

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CIRCLE 232 READER SERVICE CARD

mers have been compounded with various physical properties. Static annulus (with varying groove configuration), rotating shaft, and reciprocating shaft functional test jigs have been designed and manufactured. Seal tests, under various environmental and mechanical conditions, have been run in these jigs.

No definite relationship between physical properties and seal efficiency was found. There are, however, two physical properties that tend to affect seal life. These are compression modulus and compression relaxation. Generally, increasing the compression modulus value from 200-350 psi to 450-1500 psi, with the compression relaxation value above 10, will result in an increase in seal life up to 240%. The compression relaxation value is the negative slope of the curve of log time versus the ratio of the stress at time with the stress at 10 sec (S/S_{10}). In addition, it has been found that O-ring life was dependent on mechanical and environmental conditions under which the O-ring must seal temperature, fluid pressure, type of fluid, gland sealing, surface finish, and gland configuration.

Table of Natural Logarithms For Arguments Between 0 and 5-to-16 Decimal Places

National Bureau of Standards. Available from Superintendent of Documents, US Government Printing Office, Washington 25, DC. 10 x 7, 501 pp. $3.25.

Logarithms are one of the most common mathematical functions. Mathematicians, physicists, and engineers should find this table very labor-saving whenever the logarithm of a number given to more than four places is needed. The tables are also applicable and of great value in the preparation of many mathematical tables of other functions.

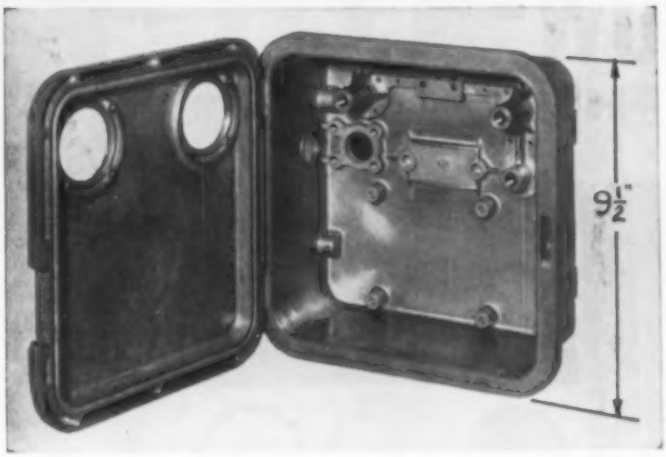
Nondestructive Tests in the Field of Nuclear Energy

Published by ASTM, Philadelphia. 9 x 6, 395 pp. Price $10; to members of participating societies, $7.50.

This symposium evolved from the meetings of an informal committee set up by AEC contractors dealing with the general subject of nondestructive testing. These included representatives from the National Labo-

(Continued on page 167)

WHY ALUMINUM DIE CASTINGS?



Pressure controller cases, which must carry pressure in certain areas and be dust tight overall can be made in two or more component parts—each part is an integral piece.

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type A standard

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	1/8	2100	1840	3690
	5/32	3000	2880	5720
	3/16	4400	4140	8240
	1/4	7700	7360	14720
	5/16	11500	11500	22960
	3/8	17600	16580	33160
	7/16	20000	22540	45000
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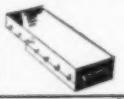
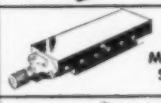
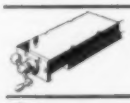


HEAVY DUTY BASIC TYPE

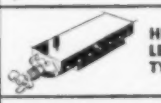
LIGHT DUTY TYPE WITH RETURN SPRING



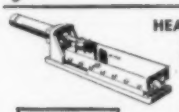
HEAVY DUTY MICROMETER STOP TYPE



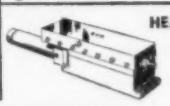
LIGHT DUTY LEAD SCREW TYPE



HEAVY DUTY LEAD SCREW TYPE



HEAVY DUTY CYLINDER POWERED (in-line mount)



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ratories, the plutonium plants and several other AEC contractors. Considerable development of ultrasonic and eddy-current test procedures had been accomplished, and in addition work had been done on several other types of nondestructive testing. Applications had been made in the inspection of castings, tubing, unclad fuel element components, and clad fuel elements.

Calculus of Variations and Its Applications

Edited by Lawrence M. Graves. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36. 10x7, 153 pp. $7.50.

This volume contains the papers presented at the Eighth Symposium in Applied Mathematics, sponsored by the American Mathematical Society and the Office of Ordnance Research on April 12-13, '56, at the University of Chicago. The symposium was devoted to a consideration of the calculus of variations and its applications.

The applications discussed were related to elasticity and plasticity, hydrodynamics, and dynamic programming. The addresses include some of the latest ideas of leading mathematicians and authorities in their fields.

The contributors include: Eric Reissner, D. C. Drucker, Joseph B. Keller, J. B. Diaz, J. L. Synge, M. M. Schiffer, Richard Bellman, S. Chandrasekhar, and E. H. Rothe. In addition to the nine addresses, two brief notes by P. G. Hodge, Jr and H. F. Weinberger are included which embody discussion of the papers by D. C. Drucker and J. L. Synge.

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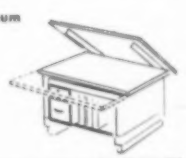

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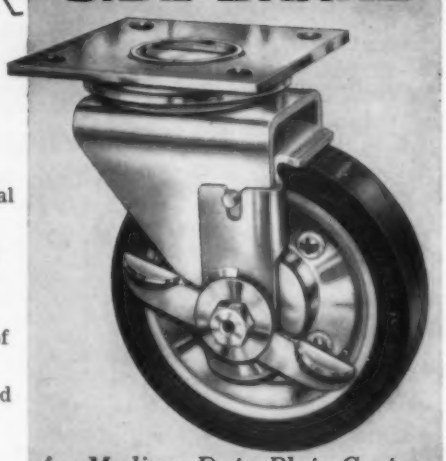

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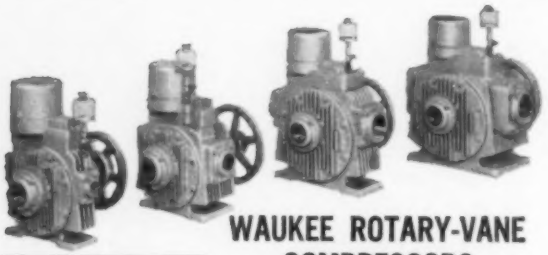

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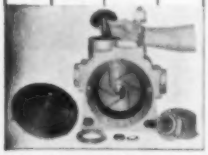
with built-in pressure regulator
400 to 6000 CFH at 1 to 3 psi

CAPACITY TABLE			
Model	CFH	Approx. RPM	Motor Size
B	400	650	1/3
C	600	700	1/2
D	750	850	1/2
H	1000	750	1/2
J	1250	850	3/4
E	1500	1050	1
K	2000	750	1
L	2500	900	1 1/2
M	3000	1100	1 1/2
P	4000	700	2
T	5000	850	2
V	6000	1000	3



Waukee Compressor: shows rotor and blades; automatic by-pass regulator piston and diaphragm assembly.

For complete specifications, write for Bulletin 430.

The Waukee Compressor supplies a steady flow of pulsation-free air or gas mixtures at pressures of 1, 2, or 3 psi. Featuring air cooling, rotary-vane construction, and a built-in automatic by-pass regulator, the Waukee Compressor is smooth, quiet and dependable. Also available for vacuum application.

Whether for OEM or replacement use, the Waukee Compressor provides a neat, sturdy, compact installation. Its rotary-vane design has few moving parts; no metal-to-metal contacts. Ball bearings are permanently lubricated with silicone grease. This simple construction means that any good mechanic can service a Waukee Compressor.

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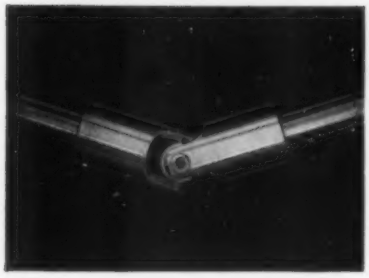
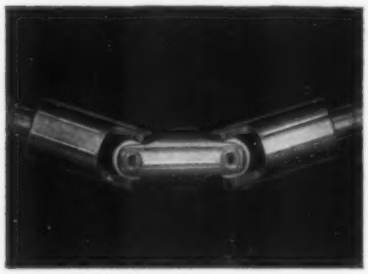
How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



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Tap the Reserve Strength in Metal
Charts and formulas for determining how far beyond the yield strength you dare go. Sep 29, '58. *Circle E 49*

Springs that Store Energy Best
How shape and material govern efficiency; with comparison tables. Nov 10, '58. *Circle E 48*

Which Tachometer for Measuring RPM?
Rotational speed can be clocked with many devices, selection chart matches the method to the need. Nov 10, '58. *Circle E 47*

Microfilm
How miniaturization of records can solve administrative problems and save design time. Oct 27, '58. *Circle E 46*

Numerical Control of Machine Tools
How it works; where it's heading. Oct 27, '58. *Circle E 45*

Optical Projectors
How projectors may be used in development, research and laboratory testing. Chart gives limitation and advantages of 30 conditions. Mid-Sep '58. *Circle E 44*

Three New Rigid Thermoplastics
Delrin, Lexan and Pro-fax are compared; curves and tables. Sep 29, '58. *Circle E 43*

Magnetic-force Welding
New welding method for vinyl-clad steel, with data on strengths and arrangements. Sep 15, '58. *Circle E 42*

Electroluminescence
Roundup on this new area-source of light which needs no filament, arcing or activating rays. Sep 15, '58. *Circle E 41*

Engineering in Europe
Editor Tangerman's report on engineering and design uncovered during his European trip. Sep 1, '58. *Circle E 40*

Selecting Polyphase Motors
Tables match drive-load characteristics with motor designs in terms of torque slip and duty cycle. Aug 18, '58. *Circle E 39*

Backlash in Spring Clutches
How two spring modifications can control backlash. Aug 18 '58. *Circle E 38*

Swivel Joints
Guide for choosing swivels and other flexible hose-type connections. Aug 4, '58. *Circle E 37*

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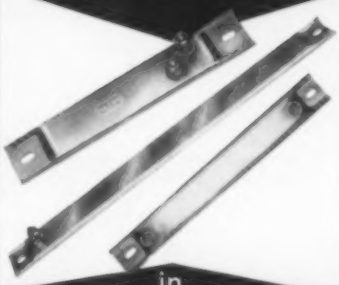

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BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

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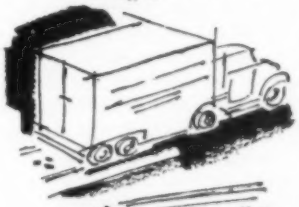

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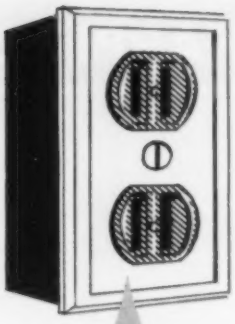

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Separate Bolts, Nuts and Washers complicate inventories, increase assembly costs.
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Washers as integral parts of bolts and nuts eliminate problems, speed assembly at lower cost.

Save Money

by simplifying fastener design

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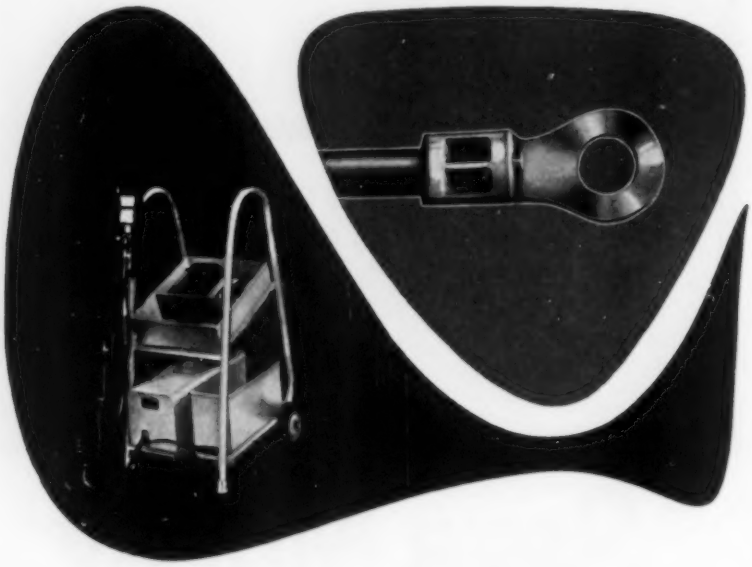
and DYNA-CRIMP® tools—



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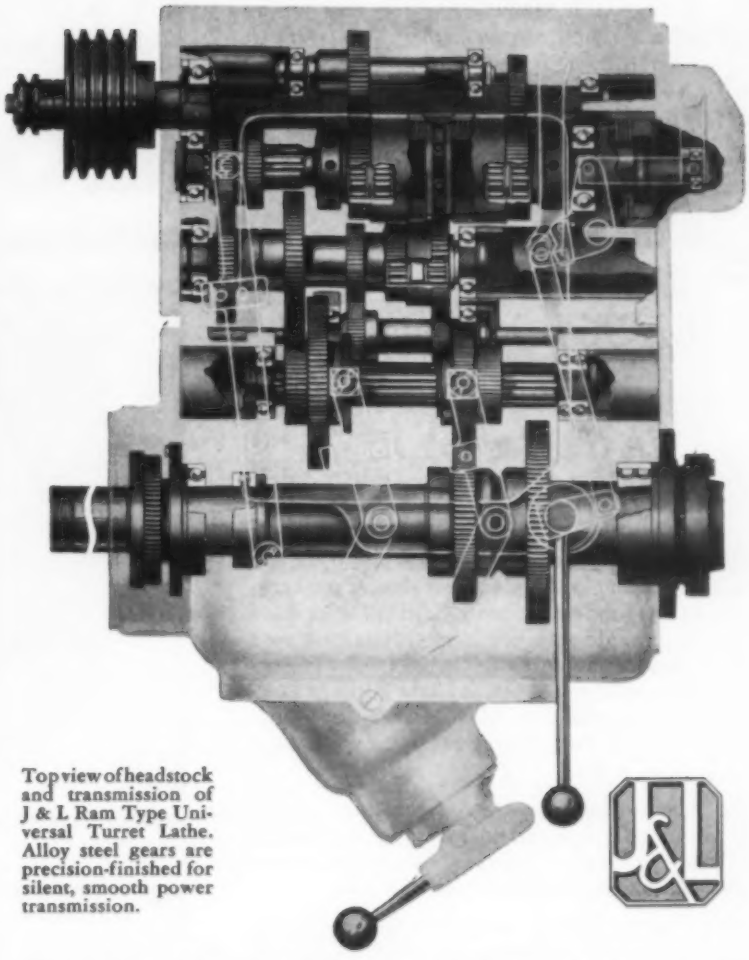

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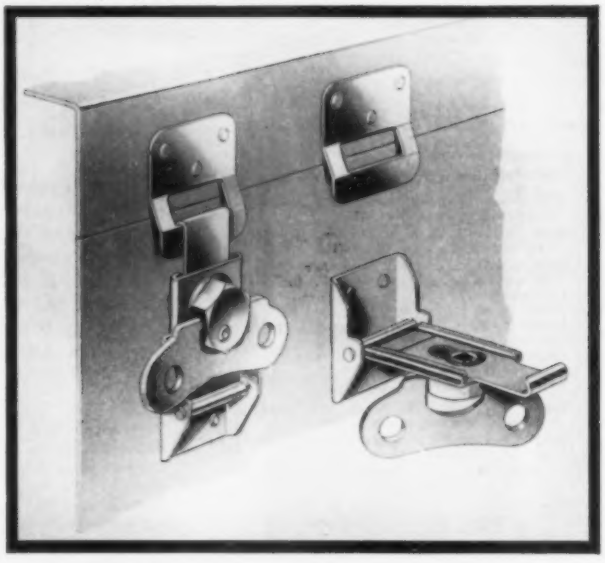
Courtesy of Pressurform Container Corp., and the LMEE Dept. of General Electric Co.



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4—Integrally-powered Timer
6—Subminiature Switch
7—Voltage Sensing Relay
11—Fail-safe Control System
20—Neon Pilot Lights
25—Lever-action Panel Switch

HYDRAULIC, PNEUMATIC EQUIPMENT
8—Solenoid Valves
10—Miniature Flowmeter
13—Direct Lift Valve
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46—Tubular Products, 16 pp, J Bishop & Co.

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52—Variable-pitch Drives, 12 pp, Browning Mfg Co.

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56—Blind Bolt Fasteners, 4 pp, Huck Mfg Co.
61—Insulation Adhesives and Sealers, 4 pp, Adhesives, Coatings and Sealers Div, Minnesota Mining and Mfg Co.

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53—Miniature Electrical Connectors, 12 pp, Cannon Electric Co.
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58—Component Dry-type Transformers, 24 pp, General Electric Co.
60—Snap-acting Switches, 2 & 4 pp, Unimax Switch Div, W L Maxson Corp.

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44—Square Air Cylinders, 20 pp, Lynair Inc.
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5	17	29	41	53	65	77	89	101	113	125	137	149	161	173	185	197	209	221	233	245	257	269	281
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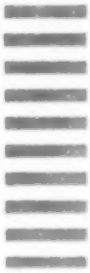

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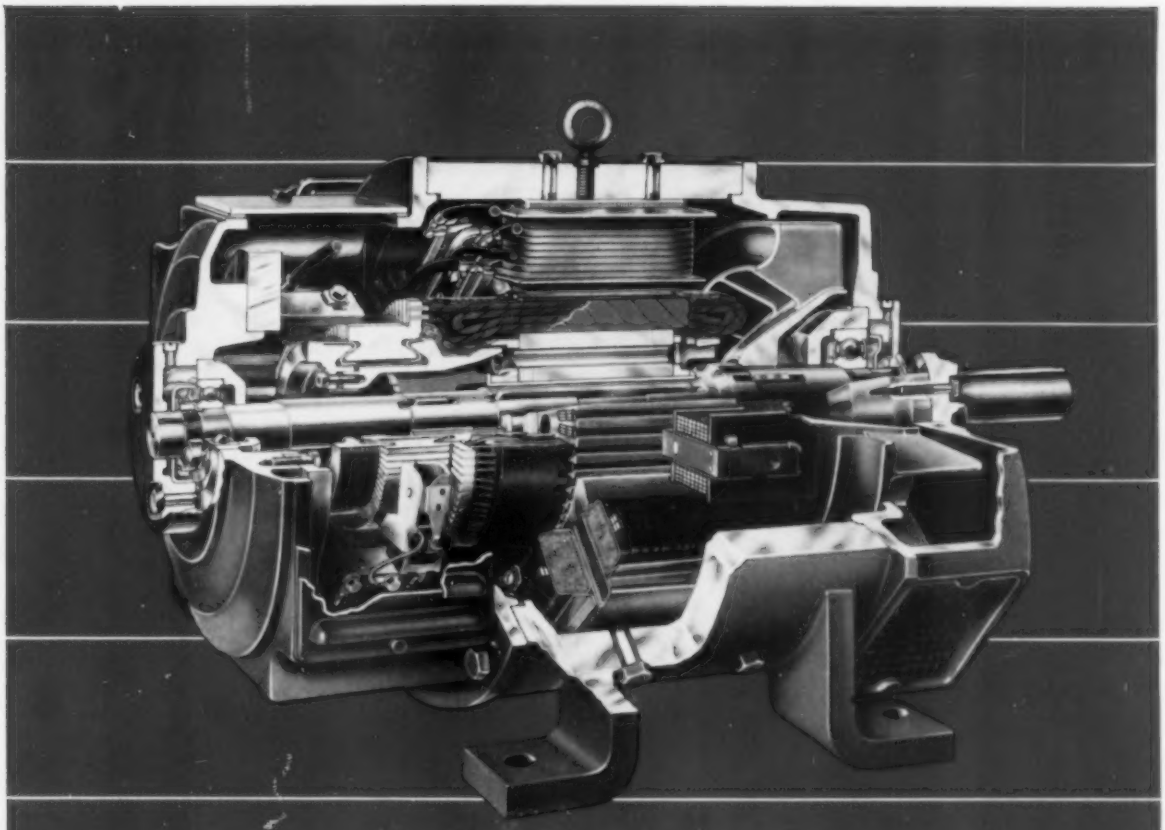

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Here is a motor built to make maximum use of d-c. flexibility. The Super 'T' puts Dynamic Response into starts, stops, and speed changes. Dynamic Response gives you a 50% increase in torque and a 50% decrease in reaction time.

This top performance is due to advanced, balanced design. Lighter small diameter armatures cut mechanical inertia 50%. Superior Class B insulation, gives extended life even at temperatures as great as 130°C.

Top grade insulation plus engineered ventilation lets the Super 'T' take tremendous overloads. In fact, the Super 'T' can develop double normal horsepower during starts, stops, and speed changes.

The Super 'T' is a compact power package, designed inside and out for tough industrial service. From appearance to performance, the Reliance Super 'T' with Dynamic Response is today's most modern industrial motor.

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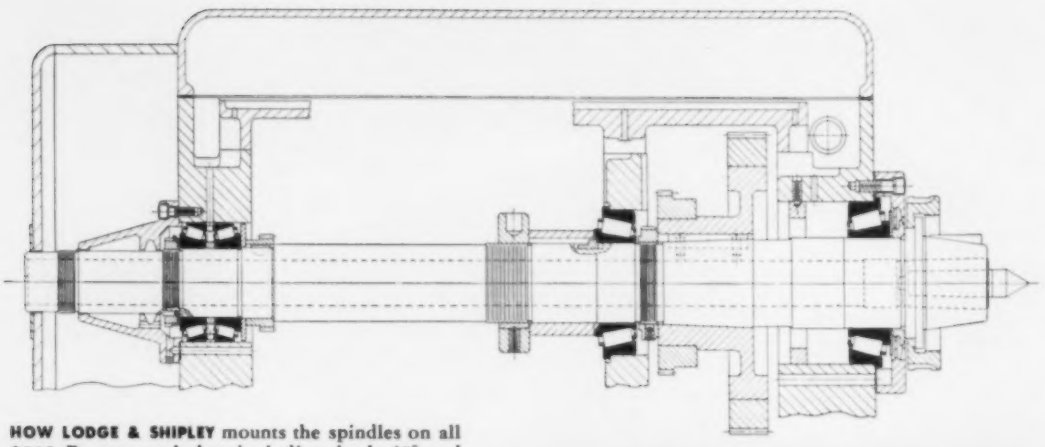
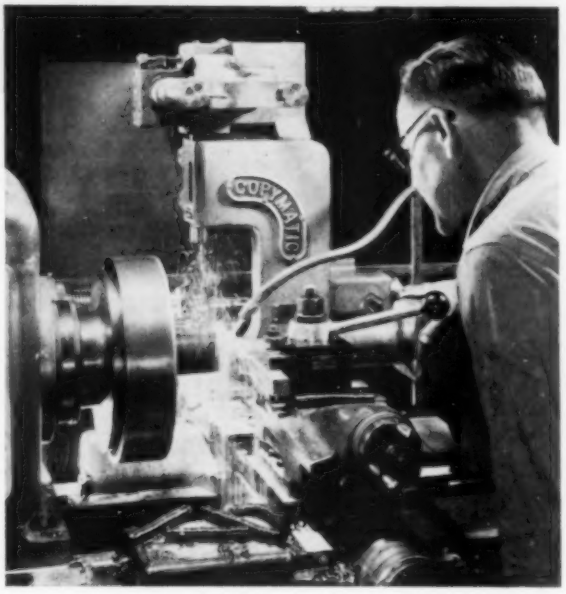


HOW LODGE & SHIPLEY mounts the spindles on all 2013 Powerturn lathes including both 45° and 90° Copymatics on Timken bearings to get extra rigidity, maintain accuracy, reduce maintenance.



New type lathe ups production 200%, saves users an estimated $8,000 a year

...one secret—TIMKEN® bearings on the spindle

"Production increases as high as 200%"..."Overall savings estimated at $8,000 a year"—read user reports about the new 2013 Powerturn 90° Copymatic Lathe. One important reason for such exceptional results is that Lodge & Shipley mounts the spindle on Timken® tapered roller bearings. Timken bearings give it the vital extra rigidity and hold runout to the minimum needed for tracer accuracy.

How spindle is held rigid. Timken bearings hold the spindle in positive alignment. They take *both* radial and thrust loads in any combination, because of their tapered design. And because of full line contact between rollers and races, Timken bearings have extra load-carrying capacity.

Why heavy shocks are absorbed. Case-carburization of Timken bearings' rollers and races gives them hard, wear-resistant surfaces and tough, shock-resistant cores.

How friction is virtually eliminated. Timken bearings are geometrically designed to roll true. And they're precision-made to live up to their design. They run smoother—last longer.

We even make our own electric furnace fine alloy steel, for extra quality control. We're America's only bearing maker that does. To get all these advantages, always specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

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